Acromag®

IntelliPack Series 851T Transmitter and Combination Transmitter/Alarm Strain Gauge Input

USER'S MANUAL

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8500-676-D04M013

Safety Summary - Symbols on equipment:

Means "Caution, refer to this manual for additional information".

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IMPORTANT SAFETY CONSIDERATIONS

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

1.0 INTRODUCTION

Series 851T Strain Gauge Transmitters and combination Transmitter/Alarms are the newest members of the popular Acromag IntelliPack Transmitter and Alarm Family. These instructions cover the hardware functionality of the IntelliPack models listed in Table 1. Supplementary sheets are attached for units with special options or features.

Table 1: Models Covered in This Manual

Series/ Input Type	-Options/Output/ Enclosure/Approvals[1]	-Factory Configuration[2]
851T	-0500[3]	-C
851T	-1500[3]	-C

Notes (Table 1):
1. Agency approvals for CE, UL Listed, & cUL Listed.
2. Include the "-C" suffix to specify factory configuration option. Otherwise, no suffix is required for standard configuration.
3. Model 851T-0500 units have transmitter functionality only, while 851T-1500 transmitters include an alarm relay.

Module programming, transmitter operation, and the IntelliPack Configuration Software is also covered in the IntelliPack Transmitter Configuration Manual (8500-570).

DESCRIPTION

Strain gauges are widely employed in sensors that detect force and force-related parameters, such as torque, acceleration, pressure, and vibration. Strain sensors undergo a small mechanical deformation with an applied force that results in a small change in resistance proportional to the applied force. They are commonly wired using the Wheatstone bridge, whose resultant output voltage is directly related to the resistance in each leg of the bridge and the bridge excitation voltage.

These models provide a single ratiometric input for interface to strain gauge sensors wired in Wheatstone bridge format, or to 6-wire load cells. The output of this transmitter is an isolated process current or voltage proportional to the measured strain. Optionally, the output includes an isolated, Single-Pole Double-Throw (SPDT) electro-mechanical alarm relay (Model 851T-1500). The module also includes an adjustable regulated bridge excitation supply. Remote sensing provides lead-wire compensation and will boost this voltage level as necessary so that the programmed excitation is applied at the remote sensor. The differential input conversion is ratiometric, making input measurements immune to changes in the excitation voltage. Sensor lead break detection is also provided. Provisions for half and quarter bridge completion are built-in. An isolated digital input is included for remotely triggering a tare conversion, or to optionally reset a latched alarm relay. Units are reconfigured, calibrated, and interrogated via our easy to use Windows 95/98/2000® or NT® IntelliPack Configuration Program.

In-field reconfigurability of transmitter zero and full-scale, plus alarm level and deadband (851T-1500 models), is also possible with front-panel push-buttons and status LED's. Front-panel push buttons can also be used to reset a latched alarm. The alarm relay has a yellow LED on the front of the module that provides a visual indication of the high or low alarm condition. Additionally, green "Run", yellow "Status", and "Zero/Full-Scale" LED's provide local feedback of operating mode, system diagnostics, and field configuration status. All IntelliPack modules contain an advanced technology microcontroller with integrated downloadable flash memory for non-volatile program, configuration, calibration, and parameter data storage. Once configured, these modules may operate independent of the host computer for true embedded monitoring and control.

The module uses a high resolution, low noise, Sigma-Delta, Analog to Digital Converter (Σ-Δ ADC) to accurately convert the input signal into a digitized value. An optically isolated Digital-to-Analog Converter (DAC) provides the corresponding process current or voltage output. A separate alarm circuit controls the relay contacts. The input-to-output transfer function of this transmitter may optionally be configured via a built-in linearizer function (up to 24-segments). The module also includes an input averaging function. The output of this transmitter may produce a normal (ascending), or reverse (descending) response. Model 851T-1500 units include an alarm relay that may be configured as a limit alarm with deadband applied, and with latching or non-latching contacts, in failsafe or non-failsafe modes. A programmed relay time delay may be implemented to help filter transients and minimize nuisance alarms.

Units are DIN-rail mounted and removable terminal blocks facilitate ease of installation and replacement, without having to remove wiring. Transmitter power, output, and relay wiring are inserted at one side of the unit, while input wiring is inserted at the other side. Plug-in connectors are an industry standard screw clamp type that accept a wide range of wire sizes.

All IntelliPack modules are designed to withstand harsh industrial environments. They feature RFI, EMI, ESD, EFT, and surge protection, plus low temperature drift, wide ambient temperature operation, and isolation between input, power, output, and relay contacts. They also have low radiated emissions per CE requirements. As a wide-range DC-powered device, the unit may be powered from DC power networks incorporating battery backup. Since the input power is diode-coupled, this offers reverse polarity protection and permits the unit to be connected to redundant power supplies. It also allows several units to safely share a single DC supply.

Flexible transmitter functionality, convenient reconfiguration, plus an optional alarm, all combine in a single package to make this instrument extremely powerful and useful over a broad range of applications. The safe, compact, rugged, reconfigurable, and reliable design of this transmitter makes it an ideal choice for control room and field applications. Custom IntelliPack configurations are also possible (please consult the factory).

Key IntelliPack 851T Features

- **Agency Approvals** - CE, UL Listed, & cUL pending.
- **Easy Windows® Configuration** - Fully reconfigurable via our user-friendly Windows 95/98/2000® or NT® IntelliPack Configuration Program.

Key IntelliPack 851T Features…continued

- **Fully Isolated** – The analog input, digital input, power, output, and relay contacts are all isolated from each other for safety and increased noise immunity.
- **Self-Diagnostics** - Built-in routines operate upon power-up for reliable service, easy maintenance, and troubleshooting.
- **Nonvolatile Reprogrammable Memory** - An advanced technology microcontroller with integrated, non-volatile, downloadable flash memory allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Convenient Field Reprogrammability** - This unit allows transmitter zero and span calibration, plus alarm setpoint and deadband adjustments, to be made via module push-buttons and LED's, thus facilitating in-field changes without having to connect a host computer. Field adjustment of tare offset is also possible via the digital input TRIG.
- **Wide-Range Strain Gauge & Bridge Inputs** – Can be configured for bridge or strain gauge applications from 1mV/V to 10mV/V.
- **True Ratiometric Input Conversion** – The A/D reference is generated from the excitation voltage and is simultaneous with the input sample, optimizing resolution and increasing accuracy. This also makes the input measurement relatively immune to errors that result from changes in excitation level.
- **Digitally Adjustable Bridge Excitation** – Constant voltage can be set from 4V to 11V, is non-volatile, and has up to 120mA of drive capability. The internal excitation can also be turned OFF for use with external bridge excitation.
- **Remote Sense -** Boosts the excitation voltage at the bridge to prevent lead-wire resistance from negatively affecting transducer span or sensitivity. Programmed level is continuously closed-loop monitored.
- **Automatic Null-Compensation** – Initial (unstrained) bridge offset voltages can be removed via software control.
- **Automatic Tare Removal** – Tare weight may be removed via software control or digital input trigger. Tare offsets may also be manually written, without having to apply a load.
- **Digital Input Provides Remote Tare or Alarm Reset** – An optically isolated digital input is provided to remotely trigger a tare conversion, or optionally reset a latched alarm relay. These functions can also be accomplished via software push-buttons, and resetting a latched alarm relay can be accomplished via the module's front panel push-buttons.
- **Bridge Completion** – Module has built-in, precision ratio-matched, half-bridge resistors and jumper terminals to accomplish half-to-full, and quarter-to-full bridge completion. The polarity of the bridge output may be varied by taking the bridge completion resistors to IN+ or IN-.
- **24-Segment Linearizer** – Optionally, the I/O transfer function may be configured via a 24 segment linearizer. Averaging may also be applied to the linearizer function.
- **Universal Analog Output** - Supports process current output ranges of 0-20mA, 4-20mA, and 0-1mA, and 0-5V or 0-10V outputs. Current outputs drive up to 550Ω, typical. Voltage outputs include short-circuit protection.
- **Normal Or Reverse Acting Output Direction** - The analog output of this transmitter may be software configured for a normal (ascending), or reverse (descending) response.
- **Wide-Range DC-Powered** – Unit is powered via a 12-36V DC supply and the power terminal is series diode-coupled, providing reverse polarity protection. This also makes this transmitter compatible with systems that use redundant supplies and/or battery back-up.

Key IntelliPack 851T Features…continued

- **Wide Ambient Operation** - The unit is designed for reliable operation over a wide ambient temperature range.
- **Hardened For Harsh Environments** - The unit will operate reliably in harsh industrial environments and includes protection from RFI, EMI, ESD, EFT, and surges, plus low radiated emissions per CE requirements.
- **Convenient Mounting, Removal, & Replacement** - The DIN-rail mount and plug-in type terminal blocks make module removal and replacement easy.
- **High-Resolution Precise A/D Conversion** - Transmitters include a high-resolution, low noise, Sigma-Delta Analog to Digital Converter (Σ-Δ ADC) for high accuracy and reliability.
- **High-Resolution Precise D/A Conversion** – Output is driven via a high-resolution, low noise, Sigma-Delta Digital-to-Analog Converter (Σ-Δ DAC) for high accuracy & reliability.
- **LED Indicators** - A green LED indicates power. A yellow status LED will turn on if input signal is out of the calibrated range. A yellow alarm LED indicates when a relay is in alarm. These LED's also have other functions in field program mode. A zero/full-scale LED is used to calibrate transmitter zero and full-scale values.
- **Automatic Self-Calibration** - Self-calibration is built-in to correct for errors due to temperature drift.

Additional Features Of Model 851T-1500 w/Alarm Option

- **Alarm Functionality ("-1500" Units Only)** - May be programmed for limit alarms with deadband, latching/non-latching contacts, and failsafe/non-failsafe operation.
- **Digital Input Provides Wired-Reset for Latched Alarms** – This module contains a digital input channel that can be used to remotely reset a latched alarm relay.
- **High-Power SPDT Relay Contacts** - Includes a Single-Pole-Double-Throw (SPDT) electromechanical alarm relay for switching voltages to 230VAC at currents up to 5A.
- **Failsafe or Non-Failsafe Relay Operation** - May be configured for failsafe or non-failsafe relay operation.
- **Configurable Setpoint With Deadband** - Includes programmable deadband to help eliminate relay "chatter" and prolong contact life.
- **Configurable Latching or Momentary Alarms** - May be configured with an automatic alarm reset, or a latching alarm with manual push-button or software reset.
- **Configurable Relay Time Delay Filters Transients** - Useful for increased noise immunity and to filter transients.

ACCESSORY ITEMS

The following IntelliPack accessories are available from Acromag. Acromag also offers other standard and custom transmitter and alarm types to serve a wide range of applications (please consult the factory).

IntelliPack Configuration Software (Model 5030-881)

IntelliPack alarms and transmitters are configured with this user-friendly Windows 95/98/200® or NT® Configuration Program. This software package includes the IntelliPack Alarm Configuration Manual (8500-563) and IntelliPack Transmitter Configuration Manual (8500-570).

These manuals describe software operation and various alarm and transmitter functions in detail. The Configuration Software also includes an on-line help function. All transmitter and alarm functions are programmable and downloadable to the modules via this software. Non-volatile memory provides program, configuration, and data storage within the IntelliPack.

IntelliPack Serial Port Adapter (Model 5030-913)

This adapter serves as an isolated interface converter between the EIA232 serial port of the host computer and the Serial Peripheral Interface (SPI) port of the IntelliPack module. It is used in conjunction with the Acromag IntelliPack Configuration Software to program and configure the modules. This adapter requires no user adjustment, no external power, and operates transparent to the user. It receives its power from the IntelliPack module. The adapter has a DB9S connector that mates to the common DB9P serial port connector of a host computer. The adapter also has a 6-wire RJ11 phone jack to connect to the IntelliPack alarm module via a separate interconnecting cable (described below). Refer to Drawing 4501-635 for computer to IntelliPack connection details.

IntelliPack Cable (Model 5030-902)

This 6-wire cable is used to connect the SPI port of the IntelliPack Serial Port Adapter to the IntelliPack. This cable carries the SPI data and clock signals, reset signal, and +5V power and ground signals. The cable is 6 feet long and has a 6-wire RJ11 plug at both ends which snap into jacks on the Serial Port Adapter and the IntelliPack module.

IntelliPack Software Interface Package (Model 800C-SIP)

The IntelliPack Software Interface Package combines the Configuration Software (5030-881), Alarm Configuration Manual (8500-563), Transmitter Configuration Manual (8500-570), Serial Port Adapter (5030-913), and Cable (5030-902), into a complete kit for interfacing with IntelliPack Alarms and Transmitters.

INTRODUCTION TO STRAIN

Because the concept of strain and its measurement & application are complex subjects, the following information has been included to help you gain a better understanding of this module and its operation. If you are already familiar with strain concepts and their application, then you may skip this section and proceed to Section 2.0 (PREPARATION FOR USE).

Strain sensors are used to measure stress forces that result from loading, torque, pressure, acceleration, and vibration. These devices are commonly arranged in Wheatstone bridge fashion. The output voltage of the strain gauge bridge is directly proportional to the applied excitation, and any resistance imbalance in the arms of the bridge. The output of the bridge is normally specified in terms of millivolts of output voltage per volt of applied excitation (mV/V), and this is usually referred to as its rated output or sensitivity. The actual maximum or full-scale output of a strain gauge bridge at its full-rated load is the product of a bridge's sensitivity (mV/V) and the applied excitation voltage. This is referred to as the output span under full rated load.

Strain is a measure of the deformation of a body when subject to an applied force. Specifically, strain (ε) is the fractional change in dimension (length, width, or height) of a body when subject to a force along that dimension. That is: **$\varepsilon = \triangle L / L$.** Note that strain can be either positive (tensile), or negative (compressive). Further, the magnitude of a strain measurement is typically very small and is often expressed as a whole number multiple of 10^{-6}, or microstrain ($\mu\varepsilon$). In most cases, strain measurements are rarely encountered larger than a few millistrain ($\varepsilon * 10^{-3}$), or about $3000\mu\varepsilon$.

When a body of material is subject to a force in one direction, a phenomenon referred to as *Poisson's Strain* causes the material to contract slightly in the transverse or perpendicular dimension. The magnitude of this contraction is a property of the material indicated by its Poisson's Ratio. The Poisson's Ratio (γ) is the negative ratio of the coincident compressive strain that occurs in the transverse direction (perpendicular to the applied force), to the strain in the axial direction (parallel to the applied force). That is: **Poisson's Ratio (γ) = $-\varepsilon_T / \varepsilon$.** Likewise, the **Poisson's Strain** (ε_T)**= $-\gamma\varepsilon$.**

Strain gauges are devices that change resistance slightly in response to an applied strain. These devices typically consist of a very fine foil grid (or wire grid) that is bonded to a surface in the direction of the applied force. The cross-sectional area of this device is minimized to reduce the negative effect of the shear or Poisson's Strain. These devices are commonly referred to as bonded-metallic or bonded-resistance strain gauges. The foil grid is bonded to a thin backing material or carrier which is directly attached to the test body. As a result, the strain experienced by the test body is transferred directly to the foil grid of the strain gauge, which responds with a linear change (or nearly linear change) in electrical resistance. As you can surmise, properly mounting a strain gauge is critical to its performance in ensuring that the applied strain of a material is accurately transferred through the adhesive and backing material, to the foil itself. Most strain gauges have nominal resistance values that vary from 30 to 3000Ω, with 120Ω, 350Ω, and 1000Ω being the most common.

The relationship between the resultant fractional change of gauge resistance to the applied strain (fractional change of length) is called the Gauge Factor (GF), or *sensitivity to strain*. Specifically, the Gauge Factor is the ratio of the fractional change in resistance to the strain:

$GF = (\triangle R / R) / (\triangle L / L) = (\triangle R / R) / \varepsilon$

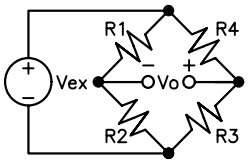
The Gauge Factor for metallic strain gauges is typically around 2.0. However, it is important to note that this ratio will vary slightly in most applications and a method of accounting for the effective Gauge Factor of a strain measurement system must be provided (see Instrument Gauge Factor).

In the ideal sense, the resistance of a strain gauge should change only in response to the applied strain. Unfortunately, the strain gauge material, as well as the test material it is applied to, will expand or contract in response to changes in temperature. Strain gauge manufacturers attempt to minimize gauge sensitivity to temperature by design, selecting specific strain gauge materials for specific application materials. Though minimized, the equivalent strain error due to the temperature coefficient of a material is still considerable and additional temperature compensation is usually required.

THE WHEATSTONE BRIDGE

Because strain measurement requires the detection of very small mechanical deformations, and small resistance changes, the resultant magnitude of most strain measurements in stress analysis applications is commonly between 2000 and $10000\mu\varepsilon$**,** and rarely larger than about $3000\mu\varepsilon$**.** As such, an accurate method of measuring very small changes in resistance is required. Likewise, this method should also compensate for the strain gauge's inherent sensitivity to temperature. This is where the Wheatstone Bridge comes into play.

The Wheatstone Bridge is comprised of four resistive arms arranged in the configuration of a diamond. An excitation voltage is applied across the diamond (or bridge input), and a resultant output voltage can be measured across the other two vertices of the diamond as shown below:



From Kirchhoff's Voltage Law and Ohm's Law, we can show that Vo = VR1 – VR4 = [R1/(R1+R2) – R4/(R3+R4)] * Vex. Note that when R1/R2 = R4/R3, the voltage output will be zero and the bridge is said to be balanced. That is, it is not required that R1=R4 and R2=R3 to achieve balance, just that the ratio of R1 to R2 and R4 to R3 be equal (this allows you to use bridge completion resistors that may have a different value than your nominal strain gauge resistance). For simplicity of illustration, if all four of the resistances in each leg of the bridge are equal, then the output voltage measured across the bridge will be zero, and the bridge is said to be balanced. Likewise, any change in resistance in any leg of the bridge will unbalance the bridge and produce a non-zero output voltage. Note also that the same output can be obtained from two different sets of adjacent resistances, as long as their ratios are equivalent (R1/R2 = R4/R3).

Recall if R1/R2 = R4/R3, then the output will be zero and the bridge is balanced. A negative change in bridge output voltage will result from a decrease in R1 or R3 (decreasing R1/R2, increasing R4/R3). Likewise, a positive change in bridge output voltage will result by a decrease in R4 or R2 (decreasing R4/R3, increasing R1/R2). With the bridge output polarity shown, a decrease in resistance R4 will produce a positive change in bridge output voltage. The equivalent strain of a decrease in R4 resistance will be negative. The general convention is that positive strain is tensile, and negative strain is compressive. Thus, a positive bridge output voltage will result from a compressive stress that decreases resistance R4 which will produce a negative strain. This is the convention used throughout this manual.

If you were to replace R4 in the bridge with an active strain gauge (Rg), any change in the strain gauge resistance ($\triangle R$) will unbalance the bridge and produce a non-zero output voltage proportional to the change in resistance. Note that the change in resistance due to the applied strain is **$\triangle R = Rg * GF * \varepsilon$.**

If R1=R2, and R3=Rg, then substituting Rg+△R for R4 in our earlier equation for Vo yields the expression: **Vo/Vex = - GF * ε / 4 * [1 / (1 + GF*ε / 2)]**, which is the *sensitivity* of this quarter-bridge circuit. The presence of the **1/(1+GF*ε/2)** term in the this expression is representative of the small non-linearity of the quarter bridge output with respect to strain. However, the effect of this non-linearity is generally small and can be ignored for quarter-bridge strain levels below about 5000 microstrain.

Note that the active strain gauge (Rg) may occupy one leg of a Wheatstone Bridge (Quarter-Bridge Configuration), two legs of a bridge (Half-Bridge Configuration), or four legs of a bridge (Full-Bridge Configuration), with any remaining legs of the bridge occupied by fixed resistors or "dummy" gauges. In any case, the number of active gauges in a bridge is key to determining whether a bridge is a quarter, half, or full bridge type.

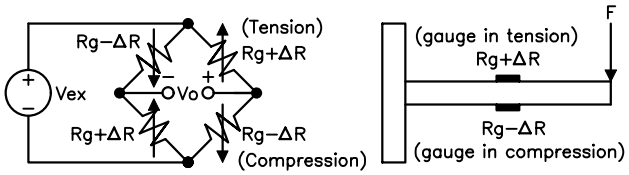
Recall that for the bridge circuit above and the polarities set as shown, tensile (positive) strains will produce a positive output voltage if located in cells 1 and 3, and a negative output voltage if located in cells 4 and 2. Compressive (negative) strains will produce a negative output if located in cells 1 and 3, and a positive output if located in cells 4 and 2. Changes of resistance in adjacent arms of the bridge are subtractive if of the same sign and they tend to cancel each other out. If the adjacent cell resistance changes are of opposite sign, they are additive. Likewise, resistance changes in opposite cells are additive if of the same sign, and tend to cancel each other out if of the opposite sign.

Because changes in resistance at adjacent bridge resistors have the same (numerically additive) effect on the bridge output when those changes are of the opposite sign, and have the opposite effect (numerically subtractive) when changes in adjacent arms are of the same sign, then by placing similar gauges and lead-wires in adjacent arms and exposing them to the same temperature, they act together to nullify their individual thermal effects on the bridge output, effectively canceling the temperature induced strain error.

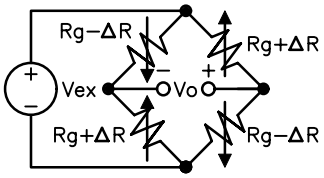
To illustrate, if you use two strain gauges in the bridge, the effect of temperature can be avoided. Substituting Rg+△R for R4 (our active gauge), and Rg for R3 (our “dummy” gauge), and by mounting the “dummy” gauge in the transverse direction with respect to the active gauge (perpendicular to the applied strain), the applied strain has little effect on the “dummy” gauge, but the ambient temperature will affect both gauges in the same way. That is, because their temperature effects are equal, the ratio of their resistance does not change, and the corresponding output voltage Vo does not change (effect of temperature is minimized).

If you choose to make the second gauge active, but in a different direction (e.g. one active gauge in tension, one active gauge in compression), you form a half-bridge configuration that effectively doubles the sensitivity of the bridge to strain. That is, the resultant output voltage is linear and approximately double the output of the quarter-bridge circuit for the same excitation.

Consider the balance beam application shown below. Solving for the sensitivity in this half bridge application yields: **Vo/Vex = - GF*ε/2**. In the figure, note that the direction of the arrows (opposing) depicts that the two active gauges are mounted such that one is in compression, and the other in tension, for the same applied strain.



You can further increase the sensitivity of this bridge circuit by making all four arms of the bridge active strain gauges, with opposite legs combined such that two legs are in compression, and two legs in tension. This forms a full-bridge circuit that has double the sensitivity of the half-bridge circuit, and four times the sensitivity of the quarter bridge circuit.



Solving for the sensitivity of the full-bridge application shown above yields: **Vo/Vex = - GF*ε.** Effectively twice that of the half-bridge circuit.

The equations presented so far have been simplified in that they assume an initially balanced bridge that generates zero output when no strain is applied. This is rarely achieved in practice where resistance tolerances and strain errors induced by the application will almost always result in an initial offset voltage (unstrained). Further, these equations also fail to account for the lead wire resistances in the connections to the excitation supply and the measurement leads.

The following section reviews permutations of the three basic bridge configurations just presented that take into account the effects of unbalanced bridges, lead-wire resistance, and the coincident Poisson’s Strain, where applicable.

STRAIN GAUGE EQUATIONS

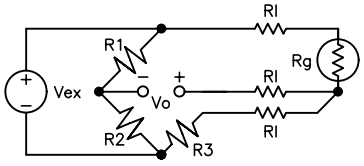
The following terms and nomenclature are used in the subsequent strain equations for the various bridge configurations. is a new term that is used to account for the non-balance condition of most unstrained bridges.

TERM	DEFINITION
Vo	Bridge Output Voltage: The convention used in this document assumes that a positive bridge voltage corresponds to a negative strain indication. Vo strained is the bridge output voltage under load. Vo unstrained is the bridge output voltage unloaded, or initial bridge offset.
Vex	Bridge Excitation Voltage
γ	Poisson’s Ratio
GF	Gauge Factor of Strain Gauge
ε	Strain (Multiply By 10^6 for micro-strain)
Vr	(Vo strained – Vo unstrained)/Vex
Rg	Nominal Strain Gauge Resistance
Rl	Lead-Wire Resistance
+ε	Denotes *tensile* Strain
-ε	Denotes *compressive* Strain
-γε	Poisson’s Strain (Transverse Strain)
N	Common Factor used To Account For Multiple Gauges In A Bridge (see Shunt Calibration)

In the examples presented in this manual for the polarities given, it is assumed that a positive strain is tensile and accompanied by a negative bridge output voltage. A negative strain is compressive and accompanied by a positive bridge output voltage. You can reverse this convention by removing the negative sign from the formulas provided and flipping the polarity of the bridge output voltage. Likewise, the internal bridge completion resistors may be taken to either IN- or IN+.

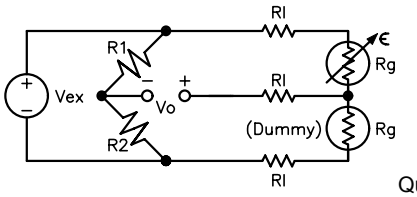
Quarter-Bridge Equations

A quarter-bridge that uses one active gauge to make uniaxial tensile or compressive strain measurements has the following general configuration:



Quarter-Bridge Type I

The first configuration (Type I) is most commonly used in experimental stress analysis, where ambient temperature is relatively constant. However, it is not recommended for real world applications as it does not compensate for changes in temperature. For the Type I configuration, the adjacent resistor in the lower arm is selected to have the same resistance as the strain gauge (R3=Rg). The two resistors in the opposite legs must be equal to each other (R1=R2), but do not have to be equal to the gauge resistor.



Quarter-Bridge Type II
(Compressive Strain)

The second configuration (Type II) is commonly used to measure compression and you may find this type of bridge configuration in weigh-scale applications. This configuration uses a single active, plus a passive or "dummy" gauge mounted transverse to the applied strain. The dummy gauge doesn't measure any strain, it is provided for temperature compensation only. That is, the applied strain has little effect on the dummy gauge as it is mounted in the transverse (perpendicular) direction (the Poisson's Strain is very small), but the ambient temperature will affect both gauges equally. Since both gauges are subject to the same temperature, the ratio of their resistances are the same, and Vo does not change with respect to temperature.

Note that the temperature compensated Quarter-Bridge (Type II) is sometimes incorrectly referred to as a half-bridge configuration due to the presence of the second gauge. But since the second gauge does not measure strain (it is not active), it is in fact a Quarter-Bridge Type II circuit and the quarter-bridge formulation applies. Note further that the quarter bridge technique cannot be used in applications where the direction of the stress field is unknown or changes.

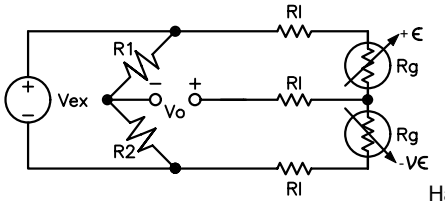
If there is any force applied in the direction of the dummy gauge, then the measurement of strain along the direction of the active gauge will be in error.

In either case, solving for the resultant strain of the Quarter-Bridge Type I or Type II configuration will yield the following expression (note the absence of Poisson's Ratio):

ε = -4Vr * (1 + Rl / Rg) / [GF*(1+2Vr)]

Half-Bridge Equations

A Half-Bridge uses two active gauges to make strain measurements and has the following general configurations:

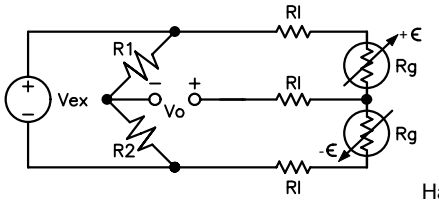


Half-Bridge Type I
(Uniaxial Strain)

Solving for the resultant strain of the Half-Bridge Type I configuration yields the following (note that Poisson's ratio is present where the transverse strain is considered):

ε = -4Vr * (1 + Rl / Rg) / [GF*(1+ γ) - 2Vr*(γ - 1)]

The Half-Bridge Type I circuit uses two active gauges in a uniaxial stress field with one gauge aligned in the direction of the applied strain, and the other gauge aligned in the transverse direction and subject to Poisson's strain. The Half-Bridge Type I circuit is similar to the Quarter-Bridge Type II circuit, except that in addition to temperature compensating the primary active gauge (the gauge mounted in the direction of the applied force), it also accounts for the effect of the transverse strain and Poisson's Ratio is included. This configuration is primarily used for uniaxial induced strain at higher levels of stress. That is, with higher stress levels come higher transverse strains. Thus, a second active gauge is mounted in the transverse direction to measure the increased level of Poisson's Strain that occurs as a result of the strain induced in the primary (axial) direction (the other active gauge measures the primary strain). The presence of the second gauge also corrects for the change in gauge resistance due to temperature, just as for the Quarter-Bridge Type II circuit.



Half-Bridge Type II
(Bending Strain)

Solving for the resultant strain of the Half-bridge Type II configuration yields (note the absence of Poisson's Ratio):

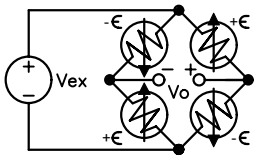
ε = -2Vr *(1 + Rl / Rg) / GF

The Half-Bridge Type II configuration uses two active gauges with equal and opposite strains, typical of a bending-beam application. In these applications, a second active strain gauge is mounted in a position that causes it to compress, while the other strain gauge undergoes tension (review the balanced beam example presented earlier). Unlike the compressive transverse strain of the Half-Bridge Type I configuration, the second gauge of the Type II configuration does not measure transverse strain. However, like the Type I, the Type II does offer temperature compensation.

Another permutation of this arrangement would have two active gauges in opposite legs of a bridge, with equal strains, but of the same sign. For example, these gauges may be mounted on opposite sides of a column with a low thermal gradient.

Full-Bridge Equations

The output signal of a half-bridge can be effectively doubled by substituting a full-bridge. A full-bridge configuration uses four active gauges to make strain measurements--two gauges measure compression, and two gauges measure tension. If opposing gauges are similarly strained, and adjacent gauges oppositely strained, the output of the full-bridge is twice that of the half bridge (and four times that of the quarter bridge). Thus, the full-bridge configuration offers twice the sensitivity of the half-bridge, but is more expensive due to the two additional gauges. Like the half-bridge, the full-bridge is balanced when all gauges undergo the same resistance change. It also compensates for changes in temperature. The Full-Bridge Type I circuit has the following configuration:

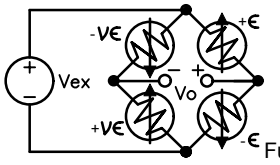


Full-Bridge Type I (Bending/Torsion)

Solving for the resultant strain of the Full-Bridge Type I configuration yields the following expression (note the absence of Poisson's strain):

ε **= - Vr / GF**.

The Full-Bridge Type I configuration utilizes four active gauges with adjacent gauge pairs subject to equal and opposite strains. This configuration is commonly applied to bending beam applications, or to shafts under torsion. These applications are arranged such that one opposite leg gauge pair is mounted to measure tensile strain, and the other opposite leg gauge pair is mounted in a position that causes it to compress, for the same applied stress (review the balanced beam example for an example of this type of mounting). In this configuration, the gauges that measure compression are not mounted to measure transverse strain.

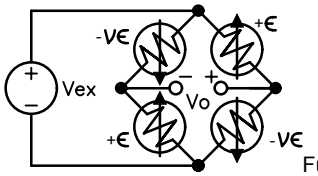


Full-Bridge Type II
(Uniaxial Bending-Beam Strain)

Solving for the resultant strain of the Full-Bridge Type II configuration yields:

ε **= -2Vr / [GF*(**γ **+ 1)].**

The Full-Bridge Type II arrangement utilizes four active gauges subject to a uniaxial stress, with two gauges aligned to measure the maximum principal strain, and the other two aligned to measure the transverse Poisson's strain, an arrangement common to bending beam applications. Note that one half of the bridge measures the tensile and compressive strains, and the opposite half of the bridge measures the compressive and tensile Poisson's strain.



Full-Bridge Type III
(Uniaxial Column Strain)

Solving for the resultant strain of a Full-Bridge Type III configuration yields:

ε **= -2Vr / [GF*(**γ **+ 1) – Vr*(**γ **- 1)].**

The Full-Bridge Type III arrangement utilizes four active gauges subject to a uniaxial stress, with two gauges aligned to measure the principal strain, and the other two aligned to measure the transverse Poisson's strain, an arrangement common to column stress applications. Note that one half of the The Full-Bridge Type III configuration is used for axial strains where four active gauges are used with one opposite leg gauge pair mounted to measure the tensile strain, and the other pair of opposite leg gauges are mounted in a position to measure compressive Poisson's strain, for the same applied stress.

Instrument Gauge Factor

The Gauge Factor of a strain gauge is a characteristic transfer coefficient that relates the resistance change in a strain gauge to the actual strain that produced it. Specifically, the Gauge Factor is the ratio of the fractional change in resistance to the strain (**GF = (**$\triangle$**R / R) / (**$\triangle$**L / L) = (**$\triangle$**R / R) /** ε**)**. The Gauge Factor for metallic strain gauges is typically around 2.0, but may vary with temperature, strain level, and gauge mounting, and this variation will contribute to error in making strain measurements.

The concept of Instrument Gauge Factor is provided as an additional means of rescaling an instrument's strain measurement system via the process of shunt calibration. The other means of rescaling the instrument is by varying its measurement Gain (set to 1 by default). The need to rescale an instrument is largely driven by the inherent lack of precision in the strain gauge parameters, as well as variations in its application. For example, the rated output (mV/V) of a strain gauge may vary by as much as $\pm$10% from the specification. Rescaling the instrument by varying its Gain or Instrument Gauge Factor allows us to account for these errors and more accurately reflect the strain.

During shunt calibration, the strain measurement is modified by varying the Instrument Gauge Factor until the reading matches a pre-calculated (simulated) strain. The calculation of the simulated strain is driven by the Gauge Factor of the strain gauge itself and a fixed gain of 1. The instrument's indicated strain is driven by the Instrument Gauge Factor and the Measurement Gain. Initially, the Instrument Gauge Factor is set equivalent to the Strain Gauge Factor, but may differ following shunt calibration. Thus, the Instrument Gauge Factor is an arbitrary transfer coefficient that can be changed "on the fly" to convert the input signal to an accurate indicated strain at the module. Any changes to the Gauge Factor must also be followed by changes to the Instrument Gauge Factor.

IMPORTANT: The Instrument Gauge Factor of this module is initially set equivalent to the strain Gauge Factor which is initially set to 2.000 by default. Thus, the indicated strain measurement will be considered equivalent to the measured strain for a strain gauge factor of 2. However, if the strain gauge factor GF $\neq$ 2 and its value changes, the Instrument Gauge Factor must also change or the indicated strain will be in error. The Instrument Gauge Factor is normally set equivalent to the Gauge Factor, then fine tuned via shunt calibration. You need to be aware that changes in Gage Factor only drive the calculation of simulated strain, but changes in the Instrument Gauge Factor drive the module's indicated strain. Alternately, the IntelliPack Configuration Software includes a Software Gain Factor that may be used to directly scale the indicated strain to the simulated strain during shunt calibration. The Software Gain Factor is initially set to 1.0 by default, but may be varied as required to rescale strain measurements following shunt calibration.

Note that with respect to the display of strain for bridge inputs via this module, the formulas presented are used internally by this module, except Instrument Gauge Factor is substituted for Gauge Factor, and the result is multiplied by a software Gain Factor for rescaling purposes (default gain is 1.000).

Determining Your Sensor Type

This module supports two input types: strain gauge bridge inputs for advanced strain measurement, or load cells for basic force measurements. Examples of load cell inputs include pressure transducers, torque converters, accelerometers, and vibration sensors. These devices may operate under compression and/or tension and yield bipolar or unipolar millivolt signals proportional to the applied force. Load cell signals are expressed in percent of span units for this module and do not require you to know any additional details of the internal bridge type, the gauge factor, or a materials Poisson's ratio, as may be required for strain gauge bridge inputs. Only the rated output and nominal excitation are considered for load cells. On the other hand, bridge inputs will use microstrain units and the formulation for strain is more complex and will require knowledge of these parameters and their application.

Bridge Inputs

The IntelliPack Configuration Software supports strain formulation for all quarter, half, and full bridge types described above. The following information is included to alleviate some of the confusion encountered in selecting the proper strain formulation for bridge input applications.

Note that all inputs to the 851T module are wired as complete full-bridge circuits with remote sense lines included. The number of active gauges, their purpose, and whether bridge completion is already provided or done internally will determine the applicable strain formula.

In any bridge configuration, it is the number of active load cells in the bridge that determine whether it is a half, quarter, or full-bridge. Additionally, the specific bridge type is determined by considering the mounting of any additional load cells in the bridge (i.e. their purpose), the presence of a "dummy" gauge, and whether or not half-bridge completion resistors are provided.

Thus, the first step to determine which bridge type applies to your application is to know how many *active* load cells are present. An "active" cell is mounted such that it will measure strain in the same direction as an applied force (either tensile or compressive). One active load cell will form a Quarter-Bridge, two active load cells will form a Half-Bridge, and four active load cells will form a Full-Bridge.

If your bridge has one active gauge and no additional dummy gauges or resistive elements present, then you select a **Quarter-Bridge Type I** formulation. However, If your sensor has one active gauge, plus a second passive or "dummy" gauge mounted transverse to the applied stress (to provide temperature compensation), then you select **Quarter Bridge Type II**. In any case, the same formula for calculating strain applies to both Quarter-Bridge types and the type distinction simply serves to specify whether the gauge is temperature compensated or not, and the steps that are necessary to complete the wiring for the full-bridge input of the 851T module. For example, both types will require half-bridge completion resistors (either external or internal), and Type I will require that a third resistor be connected in an adjacent arm to the active gauge and selected to match the resistance of the active gauge.

If your bridge has two active gauges, with the second active gauge mounted perpendicular to the applied force to measure the coincident transverse (Poisson's) strain and to temperature compensate the primary active gauge (the gauge mounted to measure strain in the same direction as the applied force), then you would select a **Half-Bridge Type I** formulation. This is commonly used to measure uniaxial strains at higher stress levels, where the effect of the transverse strain is greater and must be accounted for. Note that the Half-Bridge Type I circuit is similar to the Quarter-Bridge Type II, except that the transverse mounted gauge also measures the transverse Poisson's strain as well as temperature compensates the primary active gauge.

If your bridge has two active gauges, with both gauges mounted such that they are subject to equal and opposite strains for the same applied force, then you would select a **Half-Bridge Type II** formulation. This is commonly used in bending-beam applications, where one gauge is mounted in a position that causes it to compress while the other gauge undergoes tension. The presence of the second active gauge does provide temperature compensation, but does not measure transverse strain. Additionally, this type will require half-bridge completion resistors and these may be wired externally, or provided internally via the 851T module.

If your bridge has four active gauges, with adjacent gauge pairs subject to equal and opposite strains for the same applied stress, then you would select a **Full-Bridge Type I** formulation. This arrangement is inherently temperature compensated and does not require bridge completion.

If your bridge has four active gauges, with one half of the bridge (adjacent gauge pair) mounted to measure the tensile and compressive strain, and the opposite half mounted to measure the coincident transverse Poisson's Strains, then you would select a **Full-Bridge Type II** formulation. This type is commonly used to measure the uniaxial stress in bending beam applications. This arrangement is inherently temperature compensated and does not require bridge completion.

If your bridge has four active gauges, with one diagonal gauge pair mounted to measure the principal tensile strain, and the opposite diagonal gauge pair mounted to measure the transverse (compressive) Poisson's Strain, then you would select a **Full-Bridge Type III** formulation. This type is commonly used to measure the uniaxial stress in a column. This arrangement is inherently temperature compensated and does not require bridge completion.

Table 3 below summarizes each of the bridge configurations discussed, along with their respective strain formulation, applications, and wiring. These equations apply for the bridge output voltage in the polarity shown. Where applicable, if the bridge completion resistors connect to IN+ instead of IN- you effectively flip the polarity of the bridge output voltage and you may remove the negative sign preceding each equation. The convention illustrated in this document assumes a positive strain is tensile and will correspond to a negative bridge output voltage.

Load Cell Inputs

A simpler form of the Wheatstone bridge is the load cell. The load cell is a device principally used in weighing systems that utilizes strain gauge technology internally. Unlike the strain gauge, the output of a load cell will be expressed in equivalent units of force (not microstrain). As a result, processing a load cell signal does not require intimate knowledge of its bridge type, gauge factor, or Poisson's ratio. Rather, the important considerations of a load cell are its rated output (mV/V), its excitation, and its rated capacity.
Note that even though the load cell itself will contain permutations of quarter, half, or full-bridges, this detail is irrelevant and rarely provided by the manufacturer. Further, most load cells have bridge completion and temperature compensation already built-in.

Example 1: A compression load cell has six connection wires (sense±, excitation± , and signal ±) and is specified as follows:

Rated Capacity: 50,000 lbs/inches
Full-Scale Output: 2.0mV/V
Rated Excitation: 10V DC, 15V Maximum
Safe Overload: 150% Full-Scale
Operating Temperature Range: -65°F to 200°F

From these specifications, we can conclude the following:

- This load cell is temperature compensated (wide ambient).
- The cell already includes half-bridge compensation resistors internally (note the wiring—most common for this cell type).
- The output of this load cell is +20mV at full rated load of 50000psi with 10V of excitation (2.0mV/V * 10V).
- The output may be over-driven to +30mV at a load of 75000psi with 10V of excitation (safe overload limit).

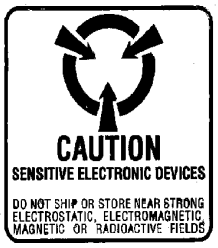
Table 3: Summary Of Bridge Types, Their Strain Formulation, Applications, and Wiring

ACTIVE GAUGES	BRIDGE TYPE (N)	ε STRAIN FORMULATION (PRIMARY APPLICATION)	BRIDGE WIRING
1	Quarter-Bridge Type I **N=1**	**-4Vr * (1 + Rl / Rg) / [GF*(1+2Vr)]** Uniaxial Compressive Strain In Constant Temperature Environments	A Single Gauge Paired With A Matching Resistor and Half-Bridge Completion Resistors.
1	Quarter-Bridge Type II **N=1**	**-4Vr * (1 + Rl / Rg) / [GF*(1+2Vr)]** Uniaxial Compressive Strain With Changing Ambient Environmental Temperatures, most common in weigh-scale load cells	A Single Gauge Paired With A Transverse Mounted "Dummy" Gauge for Temperature Compensation and Half-Bridge Completion Resistors.
2	Half-Bridge Type I **N=1+ γ**	**-4Vr * (1 + Rl / Rg) / [GF*(1+ γ) - 2Vr*(γ - 1)]** Uniaxial Strain at Higher Stress Levels	A Primary Gauge Paired with a Transverse Gauge To Measure Poisson's Strain and Provide Temperature Compensation. Requires Half-Bridge Completion Resistors.
2	Half-Bridge Type II **N=2**	**-2Vr *(1 + Rl / Rg) / GF = -4Vr*(1 + Rl / Rg) / N*GF** Bending Strain with Two Gauges Subject to Equal and Opposite Strains	One Gauge Measures Compression and Other Gauge Measures Tension For Same Applied Force. Requires Half-Bridge Completion Resistors.
4	Full-Bridge Type I **N=4**	**-Vr / GF = -4Vr / (N*GF)** Bending Beam Strain or Shafts Under Torsion with Gauge Pairs Measuring Equal and Opposite Strains	One Opposite Leg Pair Measures Compression, While Other Opposite Leg Pair Measures.
4	Full-Bridge Type II **N= 2(1+ γ)**	**-2Vr / [GF*(γ + 1)] = -4Vr / (N*GF)** Uniaxial Column Strain with One Gauge Pair Measuring the Principal Tensile and Compressive Strains and the Opposite Gauge Pair Measuring the Corresponding Transverse Poisson's Strains	One Half of Bridge Measures the Principal Tensile and Compressive Strain, Other Half Measures the Coincident Compressive and Tensile Poisson's Strains.
4	Full-Bridge Type III **N= 2(1+ γ)**	**-2Vr / [GF*(γ + 1) – Vr*(γ - 1)]** Uniaxial Column Strain with One Gauge Pair Measuring the Principal Tensile Strain and the Opposite Gauge Pair Measuring the Compressive Transverse Poisson's Strain	One Opposite Gauge Pair (Diagonal) Measures Principal Tensile Strain and Other Opposite Gauge Pair Measures the Compressive Transverse Poisson's Strain.

2.0 PREPARATION FOR USE

UNPACKING AND INSPECTION

Upon receipt of this product, inspect the shipping carton for evidence of mishandling during transit. If the shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection. For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.


CAUTION
SENSITIVE ELECTRONIC DEVICES
DO NOT SHIP OR STORE NEAR STRONG ELECTROSTATIC, ELECTROMAGNETIC, MAGNETIC OR RADIOACTIVE FIELDS

This module is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that the module be visually inspected for evidence of mishandling prior to applying power.

This circuit utilizes static sensitive components and should only be handled at a static-safe workstation.

INSTALLATION

The transmitter module is packaged in a general purpose plastic enclosure. Use an auxiliary enclosure to protect the unit in unfavorable environments or vulnerable locations, or to maintain conformance to applicable safety standards. Stay within the specified operating temperature range. As shipped from the factory, the unit is factory calibrated for all valid input ranges and has the default configuration shown in Table 2 at right (shaded entries apply to alarm-equipped Model 851T-1500).

WARNING: Applicable IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with voltages greater than or equal to 75VDC or 50VAC.

Refer to Table 2. Your application may differ from the default configuration shown and will require that the transmitter be reconfigured to suit your needs. This is accomplished with Acromag's user-friendly Windows 95/98/2000® or NT® Configuration Program and Serial Port Adapter. Configuration is normally done prior to field installation since field configurability via the module's push-buttons is generally limited to zero, full-scale, setpoint, and dropout adjustments. Note that Tare offset generation can also be triggered remotely in the field via a wired digital input signal at the TRIG & COM inputs (asserted high).

Table 2: 851T Default Factory Configuration

Parameter	Configuration/Calibration
Input Type	Load Cell
Gauge Resistance	350Ω
Strain Gauge Factor	2.0000
Poisson's Ratio	0.285
Gauge Rated Output	3mV/V
Excitation Source	Internal
Nominal Excitation	10V
Software Gain Factor	1.0000
Gauge Factor	2.0000
Instrument Gauge Factor	2.0000
Initial Bridge Offset	0.000mV
Tare Offset	0.000mV
Digital Input Function	Tare
Bridge Completion	None (Jumper Removed)
Samples	N=1 (No Input Averaging)
Output Range	0 to 10V DC (Jumper Installed)
Output Mode	Normal (Ascending) Signal.
Transmitter Scaling	Input for 0% Output = 0mV, Input for 100% Output = 30mV.
Optional Computation	None (Directly Proportional)
Alarm Mode	High Limit
Setpoint	+30mV
Deadband	0.3mV (1%)
Operating Mode	Failsafe
Time Delay	200ms
Reset Type	Automatic (momentary)

Jumper Installation (For Voltage Output Only)

For voltage output, a short jumper must be installed between the output "I+" and "JMP" terminals. A jumper wire has been included with the unit and is already installed between the "JMP" and I+ terminals. Verify jumper installation if your application requires output voltage. Remove this jumper for current output applications. Refer to the Electrical Connections Drawing 4501-886.

Bridge Completion Jumper Installation
(Refer To Drawing 4501-887)

This model includes two precision (2KΩ ±0.1%), low TC (±10ppm), half-bridge resistors that are ratio-matched to 0.02%, plus jumper terminals to facilitate bridge completion for half & quarter bridge applications. Quarter-bridge completion will also require that an external wired resistor or "dummy" gauge (not supplied) be installed close to the active gauge. Refer to Drawing 4501-887 for examples of these types of connections.

There are two industry conventions with respect to the polarity of the bridge output voltage and the bridge completion resistors of this module may accommodate both. Recall that a positive strain is "tensile" and a negative strain is compressive. With the bridge polarities illustrated and the bridge completion jumper taken to the IN- lead, a positive strain will correspond to a negative bridge output voltage and this is the convention assumed in this manual. However, with the bridge output polarity flipped and the bridge completion jumper taken to the IN+ lead instead, a positive strain will correspond to a positive bridge output voltage and this is an alternate industry convention. Connect the HALF terminal to the adjacent IN- or IN+ terminal, as required for your application.

For half and quarter bridge completion, connect a jump wire from TB2-2 (HALF) to TB2-1 (IN-), or TB2-3 (IN+), as required for your application with respect to the polarity of the bridge output voltage. Remove this jumper for full bridge connections. Note that the TB2-2 (HALF) terminal may connect the intersection of the internal half bridge resistor network to the bridge's IN- or IN+ terminal. This is done to support the convention of some equipment manufacturer's which may use an alternate relationship with respect to the bridge output signal. This is normally apparent by noting the polarity of the lead that the half-bridge completion resistors are connected to. Where applicable, this manual assumes that the half-bridge completion resistors are taken to the IN- lead and that a negative bridge output voltage will accompany a positive strain. If you adopt the opposite convention, flip the sign of the strain formulas provided such that a positive bridge output signal will accompany a positive strain.

IMPORTANT: If you are simulating a strain gauge input signal via a precision millivoltage source, then you must install this jumper to properly bias the input signal or your measurement will be in error.

Additionally, for quarter bridge completion, an external wired resistor or "dummy" gauge must be installed close to the active gauge to minimize unwanted temperature effects. This resistor is usually selected to closely match the active gauge resistance and is typically 120Ω, 350Ω, or 1000Ω. This resistor is not provided with your module as it must be selected to closely match your active gauge impedance and temperature performance, making pre-selection impractical.

Remote Tare Adjustment

Auto-tare is built into this module and allows the cancellation or "taring" of non-zero dead weight or other sensor offsets. For example, it is commonly used to remove the weight of a container from a load cell measurement. It may also be used to correct for imbalances in the input bridge or load cell circuitry. This model provides separate controls for zero balance and tare adjustment.

Tare adjustment is accomplished two ways: via the [Tare] push-button of the Configuration Software Test Page, or via an asserted digital input signal at the isolated input. The Tare trigger is asserted high with a voltage from 15-30V with respect to COM at the TRIG terminal. If your application requires frequent tare adjustment in the field, then you will have to make provisions for wiring to the TRIG and COM terminals as part of your installation. Separately, you may also have to use the IntelliPack Software to configure this digital input for tare, as it can alternately be used to reset a latched alarm relay (it is set to trigger tare by default).

Note that a tare offset will take effect immediately, but is only stored to non-volatile EEPROM memory after 10 seconds of TRIG inactivity. If power is lost during this interim period, your tare offset will be lost also. This may seem inconvenient, but is done to help preserve the life of the EEPROM, while still allowing you to change tare on the fly.

Shunt Calibration Control Wiring

This module includes provisions to accomplish shunt calibration for a shunt calibration resistor located at the module and connected across the bridge resistor via dedicated leads. Refer to Drawing 4501-886.

For convenience, you can mount a shunt resistor between the CR and CR/B terminals. Then connect a switch between the SW terminal and your gauge (SW and CR are tied together internally). The long leads of the gauge are connected from the opposite end of the switch and the module's CR/B terminal. This allows you to switch a shunt resistor in and out of the circuit as an aide in rescaling this instrument during shunt calibration.

Mounting

Refer to Enclosure Dimensions Drawing 4501-888 for mounting and clearance dimensions.

DIN Rail Mounting: This module can be mounted on "T" type DIN rails. Use suitable fastening hardware to secure the DIN rail to the mounting surface. Units may be mounted side-by-side on 1-inch centers for limited space applications.
"T" Rail (35mm), Type EN50022: To attach a module to this style of DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a module, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengauges from the rail.

Electrical Connections

Input, output, power, & relay terminals can accommodate wire from 12-24 AWG, stranded or solid copper. Strip back wire insulation 1/4-inch on each lead before installing into the terminal block. Input wiring should ideally be shielded twisted-pair. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. It is recommended that transmitter output and power wiring be separated from the input signal wiring for safety, as well as for low noise pickup. Note that input, power, output, and relay terminal blocks are a plug-in type and can be easily removed to facilitate module removal or replacement, without removing individual wires. If your application requires voltage output, you must install a jumper between the output "I+" and "JMP" terminals--this jumper is installed at the factory and should be removed for current output applications. Always remove power and/or disable the load before unplugging terminals to uninstall the module, installing or removing jumpers, or before attempting service. All connections must be made with power removed.

CAUTION: Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

1. **Power:** Refer to Electrical Connections Drawing 4501-886. Variations in power supply voltage within rated limits has negligible effect on module accuracy. For supply connections, use No. 14 AWG wires rated for at least 75°C. The power terminal is series diode-coupled for reverse polarity protection.

2. **Input:** Connect input per Electrical Connections Drawing 4501-886. Observe proper polarity when making connections (see label for input type).

IMPORTANT: If the module is powered up prior to completing the input connections, the self-calibration routine will cause an offset error to be present once the input connections are completed. You may correct this error by resetting the module or cycling power after completing the input connections. It is recommended that you always complete the input connections prior to applying power.

External Excitation: If you wish to use your own power supply to excite the bridge, you must first turn the internal excitation supply OFF. This module uses a method of ratiometric conversion in which the A/D reference is derived from the excitation supply voltage. As such, you must also complete the remote sense circuit by connecting your excitation supply to the input sense leads (SEN+ and SEN-). Refer to Drawing 4501-887 for more information.

Bridge Completion: If your load cell requires half or quarter bridge completion and you wish to employ the internal half-bridge circuit, then you must also install a jumper between the TB2-1 (IN-) & TB2-2 (HALF) terminals [or TB-3 (IN+) & TB2-2 (HALF) terminals]. For quarter bridge completion, you will also need to connect an external resistor or "dummy gauge" near the active gauge as shown in Drawing 4501-887. Refer to **Bridge Completion** section for more information.

Millivolt Source: If you are using a precision millivoltage source to simulate a strain gauge input signal, or you have selected the millivoltage input range, you must also install a jumper between the TB2-1 (IN-) & TB2-2 (HALF) terminals to properly bias the input signal. Additionally, the SEN+ and EXC+ terminals are jumpered together, and the SEN- and IN- terminals are jumpered together. The millivolt range is the ±product of the Gauge Rated Output (mV/V) and the excitation voltage settings. If simulating a load cell or bridge signal, you should also program an excitation voltage equivalent to that desired in your final application, as the A/D reference voltage is derived from the excitation voltage.

Optional TRIG Wiring: TRIG is an optically isolated digital input that may be used to trigger an auto-tare conversion, or to alternately reset a latched alarm relay, as configured via the IntelliPack software. A voltage from 15-30V with respect to COM at the TRIG terminal is sufficient to assert TRIG. The tare offset measurement will be subtracted from all subsequent bridge or load cell measurements until a new tare conversion is done or the software's [Reset Tare] button is clicked.

Optional Shunt Wiring: This module includes anchor connections for an external shunt resistor and switch that may be used to enable and disable a shunt element during shunt calibration. Refer to Electrical Connections Drawing 4501-886 for examples of these connections.

3. **Analog Output Connections**: Wire the output as shown in Electrical Connections Drawing 4501-886. For the voltage output, you must also install a jumper between the output "I+" and "JMP" terminals (installed at the factory). Remove this jumper for current output.

   Note: For sensitive applications, high frequency noise may be reduced via a 0.1uF capacitor placed across the load.

4. **Output Relay Contacts**: Wire relay contacts as shown in Electrical Connections Drawing 4501-886. See the "Alarm Relay Specifications" for power capacity.

   If necessary, an interposing relay can be used to switch higher currents as shown in the Interposing Relay Connection Drawing 4501-646.

   Electromechanical Relay Contact Protection: To maximize relay life with inductive loads, external protection is required. For DC inductive loads, place a diode across the load (1N4006 or equivalent) with cathode to (+) and anode to (-). For AC inductive loads, place a Metal Oxide Varistor (MOV) across the load. See Relay Contact Protection Drawing 4501-646 for details.

   IMPORTANT: Noise and/or jitter on the input signal has the effect of reducing (narrowing) the instrument's deadband and may produce contact chatter. The long term effect of this will reduce the life of mechanical relays. To reduce this undesired effect, you should increase the effective deadband. Note that the input averaging function of this transmitter may also be used to reduce contact chatter, but at the expense of increasing the effective response time.

5. **Grounding:** See Electrical Connections Drawing 4501-886. The module housing is plastic and does not require an earth ground connection. Input EXC- may be earth grounded.

   WARNING: For compliance to applicable safety and performance standards, the use of shielded cable is recommended as shown in Drawing 4501-886. Further, the application of earth ground must be in place as shown in Drawing 4501-886. Failure to adhere to sound wiring and grounding practices may compromise safety & performance.

3.0 CALIBRATION AND ADJUSTMENT

This transmitter/alarm module needs to be configured for your application. Complete configuration is normally accomplished using Acromag's Windows 95/98/2000® or NT® IntelliPack Configuration Program and Serial Port Adapter. This software provides controls for calibrating various aspects of the input module and the strain gauge sensor. Additionally, field controls for adjustment of transmitter zero, full-scale/span, alarm setpoint, & alarm dropout/deadband are provided. Controls for field tare offset generation and the remote reset of latched alarm relays are also provided. The operation of these controls are described in the following paragraphs.

MODULE CALIBRATION

The IntelliPack Configuration Software includes calibration controls for reference voltage and divider calibration, plus excitation endpoint calibration. These adjustments have already been performed at the factory and readjustment may not be required, except as necessary to verify operation or to satisfy your company's maintenance requirements.

This module uses a ratiometric conversion method in which the A/D reference voltage is derived from a voltage divider connected across the variable excitation supply. Thus, the input signal is sampled simultaneously ratiometric to the reference, when the input is wired as a Wheatstone Bridge. That is, the input signal and the A/D reference are both directly proportional to the bridge excitation voltage. A second A/D channel samples a fixed internal reference voltage and uses the resultant measurement to precisely determine the programmed excitation level.

This software includes controls for calibrating this reference, calibrating the bridge excitation voltage span, and for calibrating the resistor divider applied to the bridge excitation voltage that is used to generate the A/D reference. Provisions for accomplishing shunt calibration are also provided.

IMPORTANT: Allow the module to warmup several minutes prior to perfoming calibration. If the internal excitation is used, this supply should be loaded with the equivalent resistance of the gauge or load cell prior to calibrating its endpoints.

Reference Calibration
(This Calibration Must Be Performed Prior To Divider Cal)

The A/D includes a fixed reference voltage internally connected to channel 2. It periodically samples the channel 2 voltage to derive the excitation level and the corresponding A/D reference voltage. The initial reference voltage at channel 2 may vary slightly from 1.225V, and as a result, its voltage must be accurately measured and input to the firmware of the module. A small 2-pin header is internally connected across this reference for measurement via a DVM. The cover must be removed to gain access to this header. Note that this voltage has already been calibrated at the factory and readjustment is not normally necessary.

CAUTION: If you choose to make this readjustment and take this measurement, you must use strict ESD handling procedures. Otherwise, the sensitive internal circuitry could be easily damaged via ESD or an inadvertent short.

To calibrate this reference, precisely measure the voltage across P1 (cover removed). Type the measured value into the Reference Voltage Calibration Value field of the Module Calibration screen, then click the Calibrate button to store the measurement. Note that the relative accuracy of your module is strongly dependent upon the accuracy of this measurement.

Divider Calibration (Must Follow Reference Calibration)

An internal divider is comprised of precision 0.1% resistors and connected across the excitation supply voltage (at the SEN± terminals) in order to generate the A/D reference. The reference error due to the initial tolerance of these resistors can be accounted for by precisely measuring the excitation voltage across the SEN+ and SEN- terminals, then loading this value into the module via the Configuration Software. The module will compare its own internal calculation of the excitation voltage with your measured value, and then make adjustments to the divider ratio as required.

Simply measure the excitation voltage across the SEN± terminals, then input your measured value into the Divider Ratio Calibration Value field of the Input Calibration screen. Then click on the Calibrate button to store this value. The new ratio will be indicated. Again, note that the relative accuracy of your module is strongly dependent on the accuracy of this measurement.

Excitation Voltage Calibration

The internal excitation supply is varied via the resistance of a digital potentiometer tied to an adjustable regulator. This pot has an initial tolerance of ±20% which will cause the upper endpoint of the excitation to vary between 11 and 15V.

As such, the excitation endpoints must be precisely calibrated in order for the module to be able to make accurate excitation adjustments to user-programmable levels. This calibration directly determines the incremental excitation voltage or adjustment resolution (93mV typical), which is the span of this adjustment divided by 99 (a 100 value digital pot is used).

For best results, the excitation supply should be loaded with the equivalent resistance of your bridge or load cell before taking voltage measurements. Likewise, allow the module to warm-up prior to calibration. Note that the excitation supply has already been calibrated at the factory with a 350Ω load. If your load differs significantly from this, you may increase measurement accuracy via recalibration. Simply click the “Min Exc Voltage” button of the Input Calibration screen to send the excitation supply to its minimum point. Measure the excitation voltage via a DVM connected across the EXC± terminals. Type the measured value into the Excitation Voltage Low Calibration Value field, then click on the Calibrate button to store the endpoint. Repeat this process for the “Max Exc Voltage” value.

IMPORTANT: If you choose to recalibrate the excitation supply endpoints, then you should do this with the excitation supply loaded with the equivalent impedance of your bridge or load cell. Allow the module to warmup several minutes prior to calibration. Ideally, the module should be at an ambient temperature close to that of its final application.

SENSOR CALIBRATION

The IntelliPack Configuration Software also includes controls to null bridge offsets and perform shunt calibration. Additionally, controls are provided for adjusting the excitation level, setting tare, and calibrating the output. Only the controls unique to this model are reviewed in the following paragraphs. Refer to the Transmitter Configuration Manual for information on controls and adjustments common to all IntelliPacks.

Bride Balancing/ Offset Nulling

Most bridge circuits fail to output exactly 0 volts with no strain applied. Slight variations in resistance among each arm of a bridge and between the leads will contribute to some initial (unstrained) offset voltage. This offset may also be due to thermoelectric voltages generated in the circuit wiring, or via external noise sources.

The IntelliPack Configuration software includes software controls to null bridge offsets to zero. For example, you can null compensate your bridge or load cell by taking an initial measurement before strain is applied to your system, then clicking the Input Null button of the software to store the unstrained non-zero output signal. This offset will be subtracted from subsequent signal measurements, until a new Null Offset voltage is stored or the software Reset Null function is invoked.

Note that input Null automatically subtracts any current non-zero offset before writing a new value to the module. However, this is only applied correctly if the same input type is used, bridge or load cell. That is, if you wish to change input types and you already have a non-zero null offset stored, then you should click the [Reset Null] button prior to changing input types or your subsequent measurements will be in error.

This is because the null offset is stored in the engineering units of the input type--bridge types use microstrain, while load cells use percent-of-span.

Note that an offset null conversion is similar to a tare conversion, and null offsets could be conveniently combined with tare, but only if you first use Reset Null to set any initial bridge offset to zero. However, if you choose to combine the unstrained bridge offset with the tare offset, then you will not be able to extract the actual tare weight from a measurement. Note that tare measurements are typically much larger than bridge imbalances, as tare may take any value within the range of the input. By combining null with tare, a non-zero strain will be indicated with no applied stress (module indication will not return to zero with the load and tare removed). The ability to separate bridge offsets from tare is also useful in judging the operation of a bridge or load cell, as large bridge offsets are sometimes indicative of sensor problems. Additionally, tare may change values frequently for a given load cell, while the bridge imbalance usually remains constant for the measuring system. For these reasons, it is usually more convenient to keep tare offsets separate from bridge offsets and this module provides separate controls for both.

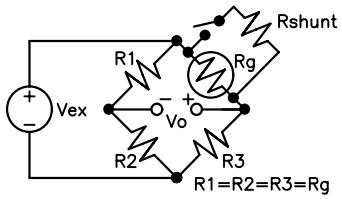
If your bridge imbalance is especially large, you may wish to determine if the offset is indeed due to a bridge imbalance, or to some other external effect like thermoelectric voltage or noise. If you simply remove the excitation from the bridge, the bridge output should be zero. If the bridge output indicated is non-zero with no applied excitation, and if this value is significant, then this output is unrelated to the strain measurement and some effort should be made to identify and remove the source of this error. Note however, that the 851T performs a ratiometric conversion of the bridge output and the A/D reference is generated from the excitation supply. Thus, the excitation voltage must be present between the remote sense leads (SEN+/SEN-) to make a measurement. That is, you can disconnect the EXC and SEN terminals from the bridge, but you must keep the EXC wires connected to their adjacent SEN terminals to complete the circuit (assuming internal excitation). Additionally, the bridge completion jumper must be present to properly bias the resultant "floating" bridge signal. Any resultant non-zero signal measurement under these conditions can be then attributed to other external effects.

Shunt Calibration

Shunt calibration is a process by which the module's sensitivity is rescaled by adjusting the module's Instrument Gauge Factor and/or its Gain, such that its indicated measurement matches a calculated (simulated) "ideal" strain. The term is a misnomer here as it does not actually calibrate the module or the strain gauge, but rather the effective sensitivity of the strain measurement system.

To accomplish shunt calibration, a large known resistance value (not provided) is placed parallel with one of the arms of the bridge to reduce the effective resistance of the arm and simulate a strain. Note that the shunt resistor does not necessarily have to shunt the active gauge, and in some cases, it may be more convenient to shunt another bridge element. The magnitude of the response will be the same, but the sign of the indicated strain will vary according to the bridge element shunted.

The shunt will affect the bridge output either positively or negatively, depending on the leg of the bridge that is shunted. If the measured response is not equivalent to the calculated strain with the shunt applied, then the module's sensitivity is typically rescaled by varying the Instrument Gauge Factor and/or Software Gain until the two values converge.



From the above figure, recall that when R1/R2 = Rg/R3, the output will be zero and the bridge is said to be balanced. A negative change in bridge output will result by shunting R1 or R3 (decreasing R1/R2, increasing Rg/R3). Likewise, a positive change in bridge output results from shunting Rg or R2 (decreasing Rg/R3, increasing R1/R2). For the polarities shown, a positive change in bridge output voltage will result when Rshunt is applied across Rg. The resultant strain obtained by shunting Rg with Rs will be negative (resistance decreases). The general convention is that positive strain is tensile, and negative strain is compressive. Thus, a positive bridge output voltage will result from a decrease in the Rg leg resistance which will produce a negative strain (compressive). This is the convention used throughout this manual.

Note that the shunt resistance (Rs) and simulated microstrain (Es) are related via the following equation (applicable at simulated strains less than 2000 microstrain):

$Rs = [Rg * 10^6 / (GF * N * Es)] - Rg$

In this equation, Rg is the resistance of the shunted gage arm, typically the nominal bridge resistance (i.e. 120Ω, 350Ω, or 1000Ω). N is a factor used to account for the presence of multiple active gauges in a bridge circuit (see table below). Es refers to the simulated strain in microstrain units and its sign is omitted. Note that GF refers to the Gauge Factor of the strain gauge, and not the Instrument Gauge Factor used by the module.

N	Bridge Type
1	Quarter Bridge Type I & II
$1 + \gamma$	Half-Bridge Type I
2	Half-Bridge Type II
$2 * (1 + \gamma)$	Full-Bridge Type II & III
4	Full-Bridge Type I

Note that the factor N can also be used to correct the strain simulated via a strain indicator calibrator. Typically, you would divide the calibrator's "dial" indication by N to get the actual strain seen by the module with its configuration set to the corresponding bridge type.

To calculated the **simulated strain** (Es) in micro-strain units solve the equation above for Es as follows:

$Es (micro-strain) = - Rg * 10^6 / (GF* N* (Rs+Rg)$

If the lead-wire resistance (Rl) is sufficiently large in comparison to the shunt resistance such that 100*Rl/Rs > 0.1 * (required calibration precision in percent), then the following calculation for Rs is more precise (note the additional term):

$Rs = [Rg * 10^6 / (GF * N * Es)] – Rg – 2 * Rl$

To apply these equations, it is assumed that the resistance of each leg of the bridge is equal and the bridge is balanced prior to performing shunt calibration. Note that the strain simulated by shunting Rg with Rs is always negative (compressive) and the negative sign is commonly omitted.

In performing shunt calibration, the simulated strain Es is calculated as shown and compared to the actual measured value of the module. If the two values differ significantly, then the measured response of the module can be rescaled by varying the module's Instrument Gauge Factor or Software Gain, until the indicated output properly registers the calculated (simulated) strain. That is, the effect of shunt calibration is to rescale the module's sensitivity, and this process is also referred to as Instrument Scaling.

To accurately perform shunt calibration, you should apply the shunt at the bridge, and not at the instrument. However, in some cases it may not be convenient to apply the shunt at the gauge. If the shunt resistor is local to the instrument, then you must provide separate leads to the bridge resistor that is to be shunted (these leads must be of equal length and gauge). For your convenience, this module provides screw terminals for installation of a shunt calibration resistor, plus connections to a switch in order to enable or disable the shunt. Refer to Electrical Connections Drawing 4501-886.

The IntelliPack Configuration Software provides an entry field for your shunt resistance (Rs), as well as a field that is used to identify the leg or bridge resistor that is shunted for a specific bridge configuration (the calibration element). A graphic figure is shown with reference designators for the standard quarter, half, and full bridge configurations. Fields for Instrument Gauge Factor and Software Gain Factor are also provided. A calculator is also built in to calculate the required shunt resistance for a specific simulated strain. With the shunt resistance applied to the bridge element, you simply click the "Update" button which will use the parameters you provided to calculate a simulated strain (this calculation uses the actual strain Gauge Factor and a fixed gain of 1.0), and simultaneously sample the input voltage and indicate its measurement using the same parameters, except the indicated value is computed with the Instrument Gauge Factor substituted for the strain Gauge Factor and the result is multiplied by the software Gain Factor. Typically, you would adjust the Instrument Gauge Factor and/or Gain Factor as required, and again click "Update", until your indicated measurement closely approximates the simulated value (internally calculated). Varying the software Gain Factor or Instrument Gauge Factor effectively adjusts the instrument's sensitivity for its indication of relative strain.

The IntelliPack Configuration Software includes a built-in Shunt Resistor Calculator that will calculate a required shunt resistance for a specific simulated microstrain. Keep in mind that the accuracy of the resistance and simulated strain calculations diminishes above simulated strains greater than about 2000 microstrain.

IMPORTANT: Shunt Calibration should only be performed on unstrained gauges. Bridge offsets should be nulled prior to shunt calibration. Always allow the module to warm up several minutes prior to performing shunt calibration.

The following table lists the simulated microstrain (compressive) for various resistance values when shunted across the active strain gauge of a quarter-bridge circuit (N=1) for 120Ω and 350Ω strain gauges. These values assume a gauge factor setting of 2.0000.

Table 3: Shunt Resistor & Simulated Strain (Quarter Bridge)

120Ω Gauges		350Ω Gauges	
Shunt	**Microstrain**	**Shunt**	**Microstrain**
1MΩ	59.8 με	1MΩ	174 με
599880Ω	100 με	349650Ω	500 με
200KΩ	299 με	200KΩ	872 με
119880Ω	500 με	174650Ω	1000 με
100KΩ	598 με	100KΩ	1744 με
59880Ω	1000 με	87150Ω	2000 με
50KΩ	1197 με	50KΩ	3476 με
29880Ω	2000 με	57983Ω	3000 με
20KΩ	2978 με	43400Ω	4000 με
19880Ω	3000 με	34650Ω	5000 με
14880Ω	4000 με	20KΩ	8510 με
11880Ω	5000 με	17150Ω	10000 με
5880Ω	10000 με		

Excitation Level Adjustment

This module employs a ratiometric input conversion method that derives the A/D reference voltage from the variable excitation voltage level. As a result, an indicated strain will remain relatively constant as the value of the excitation voltage is changed.

The output of a bridge is directly proportional to the bridge excitation voltage. Normally, the highest adjustment of bridge excitation voltage should be used while taking into account the gauge manufacturer's recommendations and the negative effect of self-heating in the bridge resistors.

The internal bridge excitation supply of this model can be adjusted from roughly 4V to 10V at the bridge, and is driven via an adjustable regulator whose output is controlled via a 100 value digital pot. The excitation level at the bridge is sensed via the remote sense lines to the bridge (SEN+ and SEN-). Remote sensing will allow the module to boost the output level so that the programmed excitation level is maintained at the remote bridge, effectively correcting for any lead resistance drop. These lines also drive the divider used to generate the reference to the A/D. A fixed reference voltage input to a second channel of the A/D (the actual A/D reference varies with excitation level) allows the excitation level to be read back in closed loop fashion. This permits the unit to make adjustments to the excitation level in order to compensate for load, lead-wire, and temperature effects. You simply enter the excitation level you desire, and the unit adjusts to that level. The excitation supply also has sufficient overdrive capability to allow up to 1V of total EXC lead resistance drop. Note that in some cases, resolution limitations will only allow the module to approximate your nominal excitation level, typically to within 93mV. Higher than expected lead-wire resistance may also limit the excitation level obtained at the bridge. In any case, the software displays the actual excitation level obtained at the bridge via the remote sense leads and this may differ from your desired excitation.

If you wish to drive your bridge via your own excitation source, the IntelliPack Configuration Software allows you to turn OFF the internal excitation supply. In this mode, you must limit your excitation voltage between 4V and 11V DC. Do not exceed these limits or damage to the unit may result. Keep in mind that the A/D reference is generated via the excitation supply and you must complete this circuit by including the EXC and SEN lead connections, just as if you were using internal excitation. Likewise, since the unit no longer has closed loop control of the excitation voltage under these conditions, make sure that your supply provides a clean, steady voltage to the bridge, or measurement accuracy may be compromised. AC bridge excitation is not permissible for use with this module.

WARNING: You must use the IntelliPack Configuration Software to turn OFF the internal excitation supply **BEFORE** you connect the unit to an external excitation source, or damage to the unit may result. Do not exceed rated excitation voltage limits.

FIELD CONFIGURATION AND ADJUSTMENT

This program mode allows adjustment to key transmitter calibration and alarm parameters in the field, without having to connect a host computer. Field reprogrammability of zero & full-scale (input to output scaling), plus alarm setpoint & deadband (Model 851T-1500), is alternately accomplished via this transmitter/alarm module's "SET", "MODE", "UP", and "DOWN" push buttons, and the zero/full-scale and relay LED's (see Drawing 4501-888) as described here.

The following procedure uses the corresponding zero/full-scale (labeled "Z/FS") and relay (labeled "RLY") LED's to indicate which parameter is being programmed. A constant ON zero/full-scale LED refers to zero configuration (scaling input for 0% output), a flashing ON/OFF zero/full-scale LED refers to full-scale/span configuration (scaling input for 100% output). A constant ON relay LED indicates setpoint adjustment, a flashing ON/OFF relay LED indicates dropout/deadband adjustment. Refer to Table 4.

Table 4: Field Configuration LED Program Indication

LED INDICATOR	CONSTANT ON	FLASHING
Yellow Zero/Full-Scale (labeled "Z/FS")	Zero	Full-Scale
851T-1500 Only Yellow Relay (labeled "RLY"),	High or Low Setpoint	High or Low Dropout

CAUTION: Do not insert sharp or oversized objects into the switch openings as this may damage the unit. When depressing the push-buttons, use a blunt tipped object and apply pressure gradually until you feel or hear the tactile response.

IMPORTANT: This module performs a ratiometric conversion of the input signal and the A/D reference is derived from the bridge excitation voltage via the sense leads. Thus, the module requires that the excitation and sense lead connections be intact in order to complete a conversion. That is, simply connecting a millivolt source to the input in order to simulate a bridge signal will not work without also completing the excitation and sense wiring, and installing the half-bridge completion jumper at TB2-1 & TB2-2 (to properly bias the input source).

If using a precision millivoltage source to drive the input, it is suggested that you also adjust the internal excitation source to a level that will approximate your final application (the A/D reference is derived from the excitation).

Prior to field calibration, the module's input type, bridge configuration, excitation level, and sensitivity must already be set via the IntelliPack Configuration Software. Input levels outside of 150% of full rated load (excitation level multiplied by sensitivity) will not be acceptable for zero, full-scale, setpoint, or dropout calibration. Since input levels cannot be validated during field programming, entering incorrect signals can produce an undesired output response. Install a jumper between the output "I+" and "JMP" terminals for voltage output, remove this jumper for current output.

Equipment Required

A bridge calibrator, strain indicator calibrator, simulator, or weights/dummy loads may be used as an input source. Optionally, a precision millivolt source may also be used to drive the input. In any case, the resultant signal source must be accurate over the range required for zero and full-scale, and alarm setpoint and dropout levels.

Note: For best results, the input source must be accurate beyond the required specifications. An accurate current or voltage meter is also required to monitor the output level. Ideally, this meter must be accurate beyond the module specifications.

Before attempting field calibration, consider that in the field, the use of an application's actual sensor, load cell, or bridge arrangement can make field calibration impractical in some cases, as it would require that precise calibration loads or stresses be applied, including load equivalents for alarm levels, as well as zero and full-scale. Further, the accurate simulation of strain gauge bridges is often impractical due to wide variances in their application and offsets. Complete calibration is most easily accomplished via the IntelliPack Configuration Software.

Transmitter/Alarm General Field Programming Procedure

Field configuration of zero and full-scale via the front panel push-buttons is essentially equivalent to the scaling operation performed via the Transmitter Configuration page of the IntelliPack software. That is, you define the input for 0% output, and the input for 100% output. However, in field calibration, you may map a minimum input signal to an output signal up to 20% of nominal full-scale, and a maximum input signal to an output signal from 60 to 110% of nominal full-scale. In other words, your zero calibration may include offset (up to 20%) and you do not have to use an equivalent full-scale load to accurately calibrate your output response (you can use 60-110% of full-scale). You may choose to include tare in your field zero calibration, but are limited to 20% of full-scale. For greater tare weights, you can always trigger tare offset generation in the field without limitation via the digital input trigger (see Electrical Connections).

Note: The bridge excitation level, the gauge rated output, and the input type/wiring can only be set via the IntelliPack Configuration Program. Calibration is optimally performed via the Intellipack Software, but field program mode provides an alternate form of input-to-output calibration by allowing you to scale virtually any portion of the input range to the selected output range via the front panel push buttons, and tare generation via the digital input.

In the following example, assume that we are using a 2mV/V compression cell rated for full output at 100lbs with nominal excitation of 10V, and 50% over capacity. Thus, this load cell will output +20mV when excited by 10V with 100lbs applied.

IMPORTANT: Field calibration operates on Xmtr Configuration parameters and will change your "Input for 0% Output" and "Input for 100% Output" software parameters. As such, you should perform tare prior to calibrating the unit via the front-panel pushbuttons.

Transmitter/Alarm Programming Procedure

1. Connect your load cell (or simulator) to the input, as required (refer to Electrical Connections Drawing 4501-886). Be sure to include the excitation and sense lead connections which are required for ratiometric conversion. Also, connect a precise current milliampmeter or voltmeter to read the output signal from the transmitter.
2. Apply power and the module's green "Run" LED will light.
3. Press and hold the **"MODE"** push button until the green "Run" LED turns OFF and the yellow "Zero/Full-Scale" LED turns ON. In this mode, the unit is ready to accept a zero input for the transmitter (equivalent to the scaling input for 0% output). If you do not wish to change the zero parameter, skip to step 7.
4. Adjust the input signal to the zero load equivalent (this value must be within the range capability of the load cell). You may choose an input equivalent up to 20% of full-scale. For our example, assume this corresponds to a calibrated load of 10% (10lbs or 2mV).
5. Press the **"UP"** or **"DOWN"** push-button once. Refer to the Functional Block Diagram 4501-885 and note that internally, the output of the Range Adjust Box is now set for 0.0% for the input zero value of 10lbs (2mV). The transmitter will adjust it's output to the minimum output value (4.000mA). If the measured output is not exactly at the zero level (4.000mA), press the UP or DN switches continuously until the desired output is achieved. You may adjust the output up to 20% of full-scale.
   Note: After first pressing the UP & DN push-buttons, they will function as trim adjustments for the output stage. The minimum output trim adjustment should be limited from about ±10% of full-scale around the nominal range endpoint. Each successive depression of the "UP" or "DN" switch will increment or decrement the output signal by a small amount. Holding the switch depressed will increase the amount of increment or decrement.
6. Press the **"SET"** push-button to accept the zero value. Note that every time "SET" is pressed, the yellow "Status" LED will flash once and the zero output will be captured.
7. Press the **"MODE"** push button one time. The yellow "Zero/Full-Scale" LED will flash on/off, indicating that the unit is ready to accept the full-scale value (equivalent to the scaling input for 100% output). If you do not wish to change this parameter, skip to step 11.
8. Adjust the input source to the full-scale load equivalent (the input value must be less than 150% of full rated load and greater than the zero value). For our example, assume this corresponds to a calibrated load of 100lbs (20mV). **Note:** If the zero and full-scale points are chosen too close together, performance will be degraded.

Transmitter/Alarm Programming Procedure…continued

9. Press the **"UP"** or **"DOWN"** push-button once. Refer to Functional Block Diagram 4501-885 and note that internally, the output of the Range Adjust Box is now set for 100.0% for the input full-scale value of 100% (100lbs or 20mV). The transmitter will adjust it's output to the maximum output value (20.000mA). If the output is not exactly at the full-scale level (20.000mA), press the UP or DN switches continuously until the desired output is achieved.
   You may adjust the output to a level from 60-110% of full-scale. **Note:** After first pressing the UP & DN push-buttons, they will function as trim adjustments for the output stage. The maximum output trim adjustment should be limited from 60 to 110% of the nominal full-scale endpoint. Each successive depression of the "UP" or "DN" switch will increment or decrement the output signal by a small amount. Holding the switch depressed will increase the amount of increment or decrement.
10. Press the **"SET"** push-button to accept the full-scale value. Note every time "SET" is pressed, the yellow "Status" LED will flash once and the full-scale output will be captured.
11. If you are configuring an 851T-0500 model, which has no alarm function, then you should skip steps 12-17 and jump ahead to step 18.
12. Press the **"MODE"** push button one time until the yellow zero/full-scale LED goes out and the yellow relay LED turns ON (see Table 4). In this mode, the unit is ready to accept an input setpoint level for the alarm. If you do not wish to change the setpoint, skip to step 15.
    Note: The setpoint can be set to any value within the input range regardless of the zero/full-scale settings.
13. Adjust the input source to the High or Low alarm load equivalent. For our example, assume 110% (110lbs or 22mV). This is your alarm setpoint level.
14. Press the **"SET"** push button to accept the setpoint. Note that every time "SET" button is pressed, the yellow status LED will flash once and the value at the input will be captured.
15. Press the **"MODE"** push button one time and the yellow relay LED should start flashing (see Table 4). This means that the unit is ready to accept the dropout level for the alarm relay. If you do not wish to change the dropout, skip to step 18.
16. Adjust the input source to the desired dropout level load equivalent. For our example, assume 100% (100lbs or 20mV).
17. Press the **"SET"** push button to accept the input dropout level. Note that every time the "SET" button is pressed, the yellow status LED will flash once and the value at the input will be captured. The module will use the difference between the setpoint and dropout values to calculate relative deadband. For our example, this is 10% (10lbs or 2mV).
18. Press the **"MODE"** push button one time to complete the program sequence and return to run mode. The green "RUN" LED will turn ON, the yellow "Zero/Full-Scale" LED will be OFF, and the yellow alarm LED will be on or off according to the alarm status.

    The module will now assume a transfer function based on the zero and full-scale values just set. The setpoint and dropout of 851T-1500 units determines the alarm deadband.

Note that field adjustment of zero and full-scale can eliminate the need to perform separate null or tare offset operations via the configuration software by combining the offset(s) with field zero calibration (up to 20% of full-scale). Tare offset generation may also be accomplished in the field via the digital input trigger (see Electrical Connections).

Note: If no buttons are pressed for a period greater than 3 minutes, the module will automatically revert to run mode (green "Run" LED will light) and no changes will be made to the zero, full-scale, and optional setpoint & dropout settings.

REMOTE/FIELD TARE OFFSET ADJUSTMENT

An optically isolated digital input is provided on this module that may be wired to remotely trigger a tare offset conversion, or to alternately reset a latched alarm relay (851T-1500 units only). The operative function of this active-high input is defined via the Configuration Software. By default, this input is set to function as a trigger for tare offset conversions as described here.

Auto-tare allows the cancellation or "taring" of any non-zero dead weight, or other sensor offsets, from input measurements. It is commonly used to remove the weight of a container from a load cell measurement, but could also be used to correct for imbalances in the input bridge (if the bridge offset is set to 0). Note that this module handles bridge and load cell offsets separate from tare, but the effect of both operations is similar.

Normally, tare is easily accomplished by clicking on [TARE] of the Configuration Software Test Page, but may be alternately invoked in the field by wiring a voltage signal to the TRIG digital input terminal provided on the module. A TRIG voltage from 15-30V with respect to COM, is sufficient to trigger a tare conversion of the input, but only if the digital input function has been set to control tare. The new tare offset will take effect immediately after deasserting TRIG, and will be stored in non-volatile EEPROM memory only after 10 seconds of TRIG inactivity. The tare offset will remain in effect for all input measurements until TRIG is asserted again later, or the [Tare]/[Reset Tare] software buttons are invoked. Note however, that TARE is not inclusive of itself—that is, a tare measurement does not include any prior tare offset.

REMOTE/FIELD RESET OF LATCHED ALARMS

A digital input channel is provided on the module that may be wired to remotely reset a latched alarm relay, or alternately trigger a tare offset conversion (described above). This input is active-high and its operative function is defined via the Configuration Software. By default, this input is set to function as a trigger for auto-tare, but may be alternately defined as a reset for a latched alarm relay via the Configuration Software for 851T-1500 models. Note that a latched alarm relay can be reset four ways: by turning the power off momentarily, via software control, via the front-panel push-buttons, or remotely via this digital input.

A TRIG voltage from 15-30V with respect to COM is sufficient to assert the trigger and reset the latched alarm, but only if the digital input function has been set to reset latched alarms via the Configuration Software.

4.0 THEORY OF OPERATION

OPERATION OF THE 851T

Refer to Simplified Schematic 4501-884 and Functional Block Diagram 4501-885 to gain a better understanding of the circuit. This module conditions a single strain gauge bridge input or load cell, provides alarm functionality, and generates a proportional voltage or current output signal. The module uses a differential input channel of an A/D to monitor the output signal of a Wheatstone bridge.

The A/D reference voltage is derived from the bridge excitation voltage via a voltage divider across the remote sense signal terminals. An adjustable regulator is used to generate the bridge excitation voltage and varies with the setting of a 100 point digital potentiometer. The A/D input reading is a count value that is a function of the bridge output voltage divided by the A/D reference voltage and the A/D gain. The A/D converter performs an analog-to-digital conversion of the input signal and digitally filters the signal. The digitized signal is then serially transmitted to a microcontroller. The microcontroller multiplies this count by the A/D reference divider (~ 9.09K/ 29.09K) to get the equivalent count of the bridge output voltage divided by the bridge excitation voltage. This count is then substituted for the Vr term of the strain equation and a value of strain as a function of count is calculated. This is then converted to strain units (bridge inputs) or percent (load cells) and corrected for initial offset and tare to produce a measured strain. As the input signal is ratiometric to the A/D reference, the effect of simultaneously deriving the A/D reference from the excitation voltage and measuring the bridge output produces a ratiometric input conversion that is virtually immune to changes in the excitation voltage. The microcontroller completes the transfer function according to the input type and its embedded program, then sends a corresponding output signal to an optically isolated Digital-to-Analog Converter (DAC). The DAC updates its current or voltage output in response. The microcontroller also compares the signal value to the limit value according to its alarm type, and completes all necessary alarm functions per its embedded program (851T-1500 units only). A second A/D input monitors a fixed reference voltage in order to obtain the current excitation voltage via closed-loop feedback. Since the A/D reference is related to the excitation voltage by a voltage divider, the actual excitation voltage level can then be calculated and verified against the value obtained by multiplying the incremental value by the number of digital pot cycles required to achieve the user-specified value (the incremental value is obtained by dividing the adjustment span of the excitation voltage range by 99 divisions).

The embedded configuration and calibration parameters are stored in non-volatile memory integrated within the micro-controller. However, only the functions required by an application are actually stored in memory—new functionality can be downloaded via the IntelliPack Configuration Software and the Serial Port Adapter. A wide input switching regulator (isolated flyback mode) provides an isolated excitation supply, isolated +14V output circuit supply, and isolated +5V circuit power. Refer to Functional Block Diagram 4501-885 for an overview of how the software/push-button configuration variables are arranged.

5.0 SERVICE AND REPAIR

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize the equipment before servicing.

SERVICE AND REPAIR ASSISTANCE

This module contains solid-state components and requires no maintenance, except for periodic cleaning and verification of configuration parameters (zero, full-scale, setpoint, deadband, etc). Since Surface Mount Technology (SMT) boards are difficult to repair, it is highly recommended that a non-functioning module be returned to Acromag for repair. The board can be damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module. Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain service parts and repair.

PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all installation and configuration procedures have been followed. The unit routinely performs internal diagnostics following power-up or reset. During this period, all LED's will turn ON momentarily and the green "Run" LED will flash. If the diagnostics are successfull, the "Run" LED will stop flashing after two seconds and remain ON, indicating the unit is operating normally. If the "Run" LED continues to flash, then this is indicative of a problem. In this case, use the Acromag IntelliPack Configuration Software to reconfigure the module and this will usually cure the problem. If the diagnostics continue to indicate a problem via a continuously flashing green LED, or if other evidence points to a problem with the unit, an effective and convenient fault diagnosis method is to exchange the questionable module with a known good unit.

The IntelliPack Serial Port Adapter also contains a red LED visible at the small opening in the enclosure to the right of the RJ11 receptacle. If this LED is OFF or Flashing and power is ON, then a communication interface problem exists. Note that the adapter receives its power from the IntelliPack module. A constant ON LED indicates a properly working and powered serial interface adapter. Note that problems may also arise if you elect to make your own Intellipack cable and exceed about 6 feet in length.

Acromag's Application Engineers can provide further technical assistance if required. When needed, complete repair services are available from Acromag.

6.0 SPECIFICATIONS

General: The IntelliPack Model 851T-0500 is a DC-powered transmitter which conditions either a single strain gauge transducer or Wheatstone bridge input, and provides an isolated voltage or current output. Isolation is supplied between the inputs, the output, and power. Model 851T-1500 units also include a SPDT, Form C, electromechanical relay, which provides a local limit alarm function with isolated relay contacts. This transmitter/alarm is DIN-rail mounted.

The unit is configured and calibrated with our user-friendly Window 95/98/2000® or NT® IntelliPack Configuration Program. Push-buttons on the module allow adjustment to the zero and full-scale points for the transmitter, plus setpoint and deadband, and may act as a latched alarm reset for modules with the alarm option. An isolated digital input is included to remotely trigger tare conversions, or to reset a latched alarm relay. Non-volatile reprogrammable memory in the module stores calibration and configuration information.

MODEL NUMBER DEFINITION

Transmitters are color coded with a white label. The prefix "8" denotes the IntelliPack Series 800, while the "T" suffix specifies that this device is primarily a process transmitter.

851T: Transmits and isolates a single strain gauge bridge or load cell input signal (DC millivoltage).

-X500: The four digits of this model suffix represent the following options, respectively:

X = 1 with Alarm Relay, X = 0 without Alarm Relay;
5 = Output: Transmitter Voltage or Current;
0 = Enclosure: DIN rail mount;
0 = Approvals: CE, UL Listed, and cUL Listed.

INPUT SPECIFICATIONS

Unit must be properly wired and configured for the intended input type and range (see Installation Section for details). All inputs to this module must be wired as full bridges with remote sense lines included. The unit can be configured to accept any of seven strain gauge bridge types, plus millivoltage or load cell inputs via the IntelliPack Configuration Program. The following paragraphs summarize this model's input types, ranges, and applicable specifications.

Load Cell: Provides ±input (differential) leads, ±sense leads (remote sense), and ±excitation leads (internal variable supply), for connection to 6 or 7-wire load cells (up to ±100mV). For connection to 4-wire load cells, you must jumper the module's excitation leads to the adjacent sense leads (see Drawing 4501-886).

SG Bridge: Provides ±input (differential) leads, ±sense leads (remote sense), and ±excitation leads (internal variable supply), for connection to strain gauge bridges. Two versions of quarter-bridge, two versions of half bridge, and three versions of full-bridge are supported (also millivolts—see below). Connections for half, and quarter bridge completion are also provided. Not suitable for high-elongation strain measurements.

Millivolt: Provides ±input (differential) leads for connection to a millivolt signal source in range of ±5mV to ±100mV (±100%). The millivolt input is set as a Bridge Type selection after selecting SG Bridge as the main Input Type. The millivolt range itself is set via the bipolar product of your Gauge Rated Output and Excitation Voltage settings. Note that you must also jumper the module's excitation leads to the adjacent sense leads for millivoltage input. In addition, you must also include a HALF bridge completion jumper to properly bias the input signal source, or measurement error will result (see Drawing 4501-886).

IMPORTANT: Complete input connections prior to applying power. If the module is powered up prior to completing the input connections, the initial self-calibration routine will cause an offset error to be generated once the input connections are completed. You may correct this error by then resetting the module, or cycling the power with complete input connections.

Input Units: SG Bridge input signals are expressed in microstrain units (except millivolts). Load Cell signals are expressed in percent of span units. Millivolt inputs use millivolt units.

Input Reference Test Conditions: 120Ω Bridge; 10V Excitation; 2mV/V Rated Output; ±20mV (±100%) input range; 25°C ambient; 24VDC Power; 200ms Alarm Delay.

Input Span/Range: All input ranges are bipolar and determined from the ± product of the gauge's rated output and the excitation voltage selection.

Input Over-Range: The actual internal input range is ±150% typical of the range obtained via the ± product of the gauge's rated output and the excitation selected.

Input Accuracy: Better than ±0.1% of span typical, for bipolar ranges larger than or equal to ±10mV. This includes the effects of repeatability and terminal point conformity, but does not include sensor error. Accuracy noted refers to input measurement & alarm, but does not include output accuracy.

Input Sensitivity: Accepts gauge rated outputs from 1mV/V to 10mV/V. The input signal range is the bipolar product of your excitation voltage and your gauge's rated output.

Input Impedance (Minimum): ±IN at 1MΩ, ±SEN at 29KΩ.

Input Bias Current: 1nA typical at ±IN.

Input Lead Resistance: Module has sufficient overdrive to guaranty 10V of bridge excitation with 5Ω/lead and 100mA of excitation current. Larger lead resistances or higher currents will limit the maximum bridge excitation that can be achieved.

Input Lead Break Detection: Output will be driven upscale within 1.5s for "wire-harness" failure (all 6 or 4 leads open). Output moves upscale for a single IN+ lead break, and downscale for a single IN- lead break. The output will move upscale for all other individual and combination wire failures, except for SEN- alone, and SEN- with IN+.

Note (Lead Break Detection w/ External Excitation): If you are using an *external excitation supply*, you must jumper the module's EXC± excitation terminals to their adjacent SEN± sense terminals to properly detect sense lead breakage. Note that the sense lead wiring is still required with external excitation, as the A/D reference for this model is derived from the excitation supply voltage delivered via the SEN± leads.

Input Bridge Excitation (Internal): Adjustable from 4V to 11V (100 points), up to 120mA. For maximum rated ambient temperature, the bridge resistance should be greater than or equal to 350Ω. For bridge resistance from 350Ω down to 120Ω, limit maximum ambient to 60°C. For applications with an effective bridge resistance between 87.5Ω (four parallel 350Ω bridges) and 120Ω, the maximum ambient temperature should be limited to 50°C. Lower bridge resistances may cause the internal excitation to thermal limit. Use of optional external bridge excitation does not limit the maximum ambient below 70°C. Internal excitation must be turned OFF for external excitation supply connections. The internal excitation voltage will be automatically boosted if it drops by approximately 60mV.

Input Bridge Excitation (External): 4V to 11V. Internal excitation must be turned OFF prior to connection to an external excitation supply.

IMPORTANT: Do not connect the input terminals to any external excitation voltages unless you have first used the Configuration Software to turn the internal excitation supply OFF. Failure to follow this procedure may damage the internal excitation supply.

Input Tare: Auto-tare is built in and can be triggered remotely via the TRIG digital input (200ms minimum active-low pulse), or via controls of the IntelliPack Configuration Software. Auto-Tare is commonly used to remove the weight of a container from a load cell measurement. The equivalent tare is automatically removed from subsequent input measurements until TRIG is asserted again later to trigger a new tare conversion. The Tare offset takes effect immediately, but is only written to non-volatile EEPROM memory after 10 seconds of TRIG input inactivity. This is done to preserve the life of the EEPROM, while still allowing tare to change on the fly. Note that tare measurement is not inclusive of itself and does not include any prior tare offset.

General Input Specifications

Accuracy: Ambient Temperature Effect: Better than ±0.01% of input span per °C (±100ppm/°C), or ±1.0uV/°C, whichever is greater.

Resolution: The effective resolution will vary according to your rated output (mV/V), excitation voltage, and input type selection. For example, with an excitation voltage of 10V and a rated output of 2mV/V, the internal range is ±150%, or ±1.5*0.002*10 = ±0.030V. The A/D reference voltage is (9.09/29.09)*10V = 3.125V. The ideal gain is Vref/Range = 3.125/0.030 = 104, but is limited to the nearest available gain of the A/D, or 64 (from 1, 2, 4, 8, 16, 32, or 64). The A/D will return a count value according to the formula for bipolar mode: Count = 32768*Vin*Gain/Vref + 32768. Thus, a full-scale input of 20mV will generate an internal count of 46190 (from 32768*64*0.02/ 3.125 + 32768). The effective resolution is derived as follows:

Load Cell Input Type: The 0-100% span is 46190-32768, or 13422. Thus, the internal resolution for this case is 1 part in 13422 (0.0074%). However, the actual (display) resolution for this example is limited to two digits after the decimal point if expressed in percent, or ±0.01%.

SG Bridge Input Type: From the bipolar mode equation, Vin/Vref = (Count –32768)/(32768 * Gain), and Vref= (9.09/29.09) * Vexc. Thus, Vin/Vexc = (9.09/29.09)* (Count-32768)/32768*Gain) and this is the Vr term of the strain equations (for a balanced bridge). Thus, for a quarter bridge with Rlead=0Ω, strain ε = -4 * Vr / [GF*(1+2Vr)], or –3982 microstrain at 20mV (100%). Thus, the effective internal resolution is 1 part in 3982, or 0.025%. Note that the actual (display) resolution is 1 microstrain. If the SG Bridge was a Full-Bridge Type I, the strain ε = 999 microstrain, and the effective resolution for our example is reduced to 1 part in 999.

Response Time: Measurement: 120ms typical; Analog Output: 280ms typical to within ±0.1% of the final value for a step change in the input. This assumes input averaging is set to "1" (response time will increase as the input averaging number is increased). See Relay Response Time for alarm output response.

Input Filter Bandwidth: -3dB at 30Hz, typical.

Noise Rejection (Normal Mode): -6dB @ 60Hz, typical.
Noise Rejection (Common Mode): Better than 120dB @ 60Hz, typical with 100Ω input unbalance.
Analog to Digital Converter (A/D): 16-bits, Σ-Δ converter.
Input Conversion Rate: : Every 120ms or 8 conversions per second maximum.
Input Filter: Normal mode filtering, plus digital filtering optimized and fixed per input range within the Σ-Δ ADC
Digital Input (TRIG, COM): The trigger input provides connections for a voltage signal to drive the input of an optocoupler in series with an internal series 6.65KΩ, 0.125W resistor. A 200ms minimum voltage pulse from 15-30V DC with respect to COM at TRIG is sufficient to assert the input and remotely trigger a tare offset conversion, or optionally reset a latched alarm relay. The operative function of TRIG is set to control tare by default, but can be configured as a latch reset via the IntelliPack Configuration Software.

ANALOG OUTPUT SPECIFICATIONS

These units contain an optically isolated DAC (Digital-to-Analog Converter) that provides a process current or voltage output. Note that calibration can only occur with respect to one of the outputs, voltage or current, and only one of the outputs may operate at a time.

Note: For sensitive applications, high frequency noise may be reduced by placing a 0.1uF capacitor directly across the load.

Voltage Output Specifications:
Output Range: 0-10V DC, 0-5V DC.
Output Accuracy: See Table 6.
Output Current: 0-10mA DC maximum.
Output Impedance: 1Ω.
Output Resolution: See Table 6.
Output Short Circuit Protection: Included
Current Output Specifications:
Output Ranges: 0-20mA DC, 4-20mA DC, or 0-1mA DC.
Output Maximum Current: 21.6mA typical.
Output Accuracy: See Table 6.
Output Compliance: 10V minimum, 11V typical.
Output Resolution: See Table 6.
Output Load Resistance Range: 0 to 550Ω, typical.

Table 6: Analog Output Range Resolution & Accuracy

Output Range	Resolution	Accuracy[1,2] (Percent-of-Span)	
		Output	Overall
0 to 20mA DC	0.0025%	0.025%	**0.1%**
4 to 20mA DC	0.0025%	0.025%	**0.1%**
0 to 1mA DC	0.0370%	0.100%	**0.2%**
0 to 10V DC	0.0025%	0.025%	**0.1%**
0 to 5V DC	0.0030%	0.050%	**0.13%**

Notes (Table 6):
1. Voltage outputs unloaded. Loading will add "I*R" error.
2. Software calibration produces high accuracy.
3. All current and voltage ranges are subsets of the 0-24mA range which provides under and over range capability.

General Output Specifications
Digital-to-Analog Converter: Analog Devices AD420AR-32, 16-bit Σ-Δ.
Integral Non-Linearity: ±0.002% (±1.4LSB) of span typical, 0.012% (±7.9LSB) of span maximum, for ranges utilizing full output span (0-24mA, 0-10V DC).
Output Temperature Drift: Better than ±20ppm/°C Typical, ±50ppm/°C Maximum.
Output Conversion Rate: Every 120ms or 8 conversions per second maximum.
Output Response Time: Less than 280ms typical, to within 0.1% of transition (0-10V into 10KΩ). Response time will vary with output type and load.

RELAY OUTPUT SPECIFICATIONS

Output Relay (851T-1500 Units Only): One independent Single Pole Double Throw (SPDT), Form C, electromagnetic, dry-contact sealed relay.
Note: to control a higher amperage device, such as a pump, an interposing relay may be used (see Drawing 4501-646).

Electrical Life - CSA Ratings:
25VDC, 5A, 10^5 operations, resistive.
48VDC, 0.8A, 10^5 operations, resistive.
150VDC, 0.4A, 10^5 operations, resistive.
150VAC, 5A, $3x10^4$ operations, resistive.
Contact Material: Silver-cadmium oxide (AgCdO).
Initial Dielectric Strength: Between open contacts: 1000VAC rms.
Expected Mechanical Life: 20 million operations. External relay contact protection is required for use with inductive loads (see Contact Protection Drawing 4501-646).
Relay Response (No Relay Time Delay): Relay contacts will switch within 280ms for an input step change from 10% of span on one side of an alarm point to 5% of span on the other side of the alarm point.

ENCLOSURE/PHYSICAL SPECIFICATIONS

See Enclosure Dimensions Drawing 4501-888. Units are packaged in a general purpose plastic enclosure that is DIN rail mountable for flexible, high density (approximately 1" wide per unit) mounting.

Dimensions: Width = 1.05 inches, Height = 4.68 inches, Depth = 4.35 inches (see Drawing 4501-888).
DIN Rail Mounting (-xx0x): DIN rail mount, Type EN50022; "T" rail (35mm).
Connectors: Removable plug-in type terminal blocks; Current/ Voltage Ratings: 15A/300V; Wire Range: AWG #12-24, stranded or solid copper; separate terminal blocks are provided for input, power/output, & relay contacts. For supply connections, use No. 14 AWG copper wires rated for at least 75°C.
Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

APPROVALS

CE marked (EMC Directive 89/336/EEC)
UL listed (UL3121-First Edition)
CUL listed (Canada Standard C22.2, No. 1010.1-92)

Product approval is limited to general safety requirements of the above standards.

Warning: This product is not approved for hazardous location applications.

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature: -25°C to +70°C (-13°F to +158°F) with external excitation, or with internal excitation and bridge impedance greater than or equal to 350Ω. Limit maximum ambient to +60°C with bridge impedance below 350Ω down to 120Ω, and +50°C with bridge impedance below 120Ω down to 83Ω. Lower bridge impedance may cause the excitation supply to thermal limit.
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95% non-condensing.
Power Requirements: 12-36V DC SELV (Safety Extra Low Voltage), 11.5VDC minimum. Current draw is a function of supply voltage, excitation current, output load, and circuit load (relay energized, SPA connected). Currents indicated in Table 8 assume the bridge excitation is driving 10V into 120Ω (83mA), the voltage output circuit is at 10V into 1KΩ (10mA), the relay is energized (851T-1500 only), and the Serial Port Adapter is connected. An internal diode provides reverse polarity protection.

CAUTION: Do not exceed 36VDC peak, to avoid damage to the module.

Table 8: 851T Supply Current

Supply	851T-0500	851T-1500 (Relay Energized)
12V	315mA	350mA
15V	250mA	275mA
24V	145mA	160mA
36V	105mA	115mA

Note: Supply current will be significantly reduced by reducing the excitation current and/or disconnecting the Serial Port Adapter.

IMPORTANT: Do not power-up or reset the module without first completing the input connections or the internal self calibration routine will generate an input offset error. If this occurs, reset the module or cycle power once the input wiring is complete to re-invoke self calibration.

IMPORTANT: - External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

Power Supply Effect:
DC Volts: Less than ±0.001% of output span change per volt DC for rated power supply variations.
60/120 Hz Ripple: Less than 0.01% of output span per volt peak-to-peak of power supply ripple.

Isolation: Input, output, and power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Optional relay outputs are isolated from other circuits up to 150VAC, or 150VDC.
This complies with test requirements of ANSI/ISA-82.01-1988 for the voltage rating specified.
Installation Category: Designed to operate in an Installation Category for use in a Pollution Degree 2 environment. (Overvoltage Category II rating).
Radiated Field Immunity (RFI): Complies with IEC1000-4-3 Level 3 (10V/M, 80 to 1000MHz AM & 900MHz keyed) and European Norm EN50082-1.
Electromagnetic Interference Immunity (EMI): No relay trips will occur beyond ±0.25% of input span from setpoint and no output shifts will occur beyond ±0.25% of span under the influence of EMI from switching solenoids, commutator motors, and drill motors.
Electrical Fast Transient Immunity (EFT): Complies with IEC1000-4-4 Level 3 (2KV power; 1KV signal lines) and European Norm EN50082-1.
Electrostatic Discharge (ESD) Immunity: Complies with IEC1000-4-2 Level 3 (8KV/4KV air/direct discharge) to the enclosure port and European Norm EN50082-1.
Surge Immunity: Complies with IEC1000-4-5 Level 3 (2.0KV) and European Norm EN50082-1.
Radiated Emissions: Meets or exceeds European Norm EN50081-1 for class B equipment.

FIELD CONFIGURATION AND CONTROLS

Field programming of transmitter zero and full-scale (all models), plus alarm setpoint and dropout levels (851T-1500 only), and tare is accomplished with module push-buttons and LED indicators.

Note: The unit must be initially configured via the Configuration Software before its configuration can be varied in the field. Tare conversion should be done prior to field calibration.

Module Push Buttons (See Dwg. 4501-643 For Location):
Mode - Used to change mode of field configuration.
Set - Used to accept input data during field calibration.
Up (Reset) - Used to increment output level during field calibration. Used to reset a latched alarm relay in operating mode.
Down (Reset) - Used to decrement output level during field calibration. Used to reset a latched alarm relay in operating mode.
TRIG Digital Input Terminals (Auto-Tare or Latch Reset):
TRIG – Active-high, isolated digital input trigger used to remotely trigger a tare offset conversion, or alternately reset a latched alarm relay. A 15-30V voltage from TRIG to COM is sufficient to assert this trigger (6V typical). The TRIG terminal has a resistor of 6.65KΩ in series with an opto-coupler. Be sure to limit power dissipation in this resistor to 0.125W or less. Note, if TRIG is held high, the tare function will be repeated continuously.
COM – Common for TRIG digital input signal.
LED Indicators (Operating Mode):
Run (Green) - Constant ON indicates normal operation and power is applied. Flashing ON/OFF indicates unit is

performing diagnostics (first second following power-up), or has failed diagnostics (after a few seconds).

Status (Yellow) - Flashing ON/OFF indicates an open sensor or that the input is outside of the selected input range. A constant ON indicates the input is outside of the transmitter's calibrated input range.

Zero/Full-Scale (Yellow) - OFF in Run mode.

Relay (Yellow) - Constant ON indicates alarm condition for relay. During field configuration, this LED has a different function (see below).

LED Indicators (Field Configuration Mode):

Run (Green) - Turned OFF in this mode.

Status (Yellow) - Flashes each time the "SET" push button is pressed to capture an I/O signal in this mode.

Zero/Full-Scale (Yellow) - ON or FLASHING in this mode if zero or full-scale is being adjusted (See Table 4).

Relay (Yellow) - ON or FLASHING if alarm setpoint or dropout is being adjusted (See Table 3) in this mode.

HOST COMPUTER COMMUNICATION

Host Communication Port (SPI): IntelliPack SPI port (standard RJ11 6-wire phone jack). See Drawing 4501-643 for location. Configuration information is downloaded from the host computer through one of its EIA232 serial ports. This port must be connected to the module through an Acromag IntelliPack Serial Port Adapter. This Serial Port Adapter serves as an isolated interface converter between EIA232 and the IntelliPack's SPI port.

Baud Rate (EIA232): 19.2K baud.

SOFTWARE CONFIGURATION

Units are fully reprogrammable via our user-friendly Windows 95/98/2000® or NT® IntelliPack Configuration Program (Model 5030-881). A cable (5030-902) and converter (5030-913) are required to complete the interface (Software Interface Package 800C-SIP). See Drawing 4501-643.

In addition to configuring all features of the module, the IntelliPack Configuration Software includes additional capabilities for testing and control of this module as follows:

- Monitors the input signal (microstrain or percent), excitation voltage, A/D reference voltage, and output signal values. Also monitors the input type, excitation source, input sensitivity, input range, null offset, and tare offset. Allows polling to be turned on or off.
- Allows a configuration to be uploaded or downloaded to/from the module and provides the means to rewrite a module's firmware if the microcontroller is replaced or the module's functionality is updated.
- Provides controls to separately calibrate the input circuit, the output, and the excitation supply. Also provides controls to perform shunt or load calibration, and controls to restore the original factory input or output calibration in case of error.
- Provides controls to adjust the bridge excitation voltage.
- Provides controls to null initial bridge or load cell offsets.
- Provides controls to perform shunt or load calibration to re-scale the instrument's indicator by modifying its gain and/or instrument gauge factor.
- Provides controls to trigger a tare conversion of the input signal (can also be done remotely via wired digital input).
- Provides controls to reset a module and reset a latched alarm (a latched alarm may also be reset remotely via wired digital input, or locally via front-panel push-buttons).
- Provides a control to adjust a transmitter's output signal independent of the input signal.
- Allows optional user documentation to be written to the module. Documentation fields are provided for tag number, comment, configured by, location, and identification information. This information can also be uploaded from the module and printed via this software.
- Allows a module's complete configuration to be printed in an easy to read, two-page format, including user documentation.

The following transmitter and alarm attributes are configurable via the IntelliPack Configuration Software. The descriptions provided are organized with respect to their appearance in the corresponding configuration pages of the IntelliPack Software. You may also refer to the IntelliPack Transmitter Configuration Manual (8500-570) for additional details regarding configuration attributes.

General Configuration

Input – Type: Select **SG Bridge** or **Load Cell** (see Determining Your Sensor Type). Note that the Strain Gauge Bridge type assumes the input is wired in the Wheatstone bridge format and will express its output in microstrain units. The Load Cell type assumes a 6-wire connection to the load cell and will express the output in percent-of-span units. Four-wire load cells may be accommodated (see Drawing 4501-886). Select SG Bridge if you wish to configure a millivolt input.

Input – Samples: Select the number of input samples (A/D conversions) for calculation of an average (select 1/default, 2, 4, 8, or 16) before processing the signal. Increasing samples is useful for help in filtering transients. Note that the effective response time will be increased by the factor selected. Both the alarm relay and transmitter output will use the averaged value and their response times will be affected accordingly.

Input – Digital Function (851T-1500 Only): Select the functionality of the digital input to trigger tare (default), or to reset a latched alarm relay. The digital input is asserted high by a voltage from 15-30V. On 851T-0500 units, this input is used only to remotely trigger a tare conversion.

Output - Range: Unit can be configured for either a voltage or current output range. A jumper must also be installed between the output "I+" and "JMP" terminals for voltage output (remove this jumper for current output).
Voltage: 0 to 10V DC, 0 to 5V DC
Current: 0 to 20mA DC, 4 to 20mA DC, or 0 to 1mA DC

Output - Mode: Select a normal acting (ascending), or reverse acting (descending) output response.

Strain Gauge Bridge/Load Cell Setup

Bridge – Type/Conversion (Not Applicable for Load Cell): Select from two versions of Quarter-Bridge input conversion, two versions of Half-Bridge input conversion, and three versions of Full-Bridge inputs, or millivolts. A graphic of the bridge type will be displayed including reference designators and the applicable strain formula.
Note: The selection of quarter or half bridge types will also require installation of the HALF jumper at TB2, if internal half-bridge completion resistors are used. Millivolt inputs will also require that this jumper be installed. In addition, quarter bridge conversion also requires the installation of an external

resistor or "dummy gauge" (not supplied). See Bridge Completion section for additional details.

Bridge/Load Cell – Rated Output: Enter the rated output of the bridge or load cell as specified by the manufacturer in millivolts per volt of excitation. The ±product of the rated output and the excitation will determine your ±signal range. The resultant Range is indicated to the right of this field.

Bridge/Load Cell – Signal Range: This field displays the ±product of the excitation and the gauge's rated output (all ranges are bipolar). It does not include the 50% over-range capability already built-in. Note that the transmitter output may be separately scaled to utilize only a portion of the available range if so desired.

Note: Large bridge offsets and the inability to precisely tune your selected excitation level can limit the effective input signal range to a value below the nominal range indicated.

Bridge/Load Cell – Excitation Source: Select "Int" for Internal (default), or "Ext" for External. Selecting External will disable the internal adjustable regulator.

IMPORTANT: You must set this parameter to "Ext" **before** connecting an external excitation source to the module or damage to the unit's internal excitation supply may occur. Note that the new setting is assumed following download.

Bridge/Load Cell – Nominal Excitation: If the excitation source is set to Internal, then this field allows you to specify a nominal excitation level from 4V to 11V, typical. The actual (measured) excitation is read back via the remote sense lines and displayed separately on the Test Page. Note that the nominal excitation may differ from the measured value due to limitations with adjustment resolution and any larger than expected lead resistance. Likewise, the firmware may periodically boost the excitation if it drops below level.

Bridge – Gauge Resistance (Not Applicable to Load Cells): Enter the nominal gauge resistance as specified by the gauge manufacturer. For the purposes of strain calculation, it is assumed that all gauges and/or resistors of quarter and full-bridge applications have the same resistance.

Bridge – Lead Resistance (Not Applicable to Load Cells): This is the lead resistance of the excitation and sense leads to the gauge in ohms. All leads are assumed to be of the same gauge and length.

Note: The excitation supply provides sufficient overdrive voltage to support 10V at the bridge, with up to 5Ω of lead resistance and currents up to 100mA.

Bridge – Gauge Factor (Not Applicable to Load Cells): Enter the Gauge Factor of the strain gauge as specified by the manufacturer. The default gauge factor is set to 2.000. Do not confuse this Gauge Factor with the Instrument Gauge Factor of the module. Note that the Instrument Gauge Factor is initially set equal to the Gauge Factor, but may vary following shunt calibration. The Instrument Gauge Factor is used by this module for calculation of its measured strain. The Gauge Factor here, is primarily used to calculate the simulated strain during shunt calibration and to set the initial value of the Instrument Gauge Factor. The Instrument Gauge Factor may be varied to rescale the indicated strain measurement, while holding Gauge Factor constant.

Bridge – Poisson's Ratio (Not Applicable to Load Cells): Enter the value of Poisson's Ratio for the material that the strain gauge(s) are applied to if other than 0.285 (default value). For example, the Poisson's Ratio for steel varies from 0.25 to 0.30. Note that this value is ignored for Quarter-Bridge, Half-Bridge Type II, and Full-Bridge Type I applications.

Transmitter Configuration

Transmitter - Scaling: Scaling is performed after averaging and converts the engineering units of the input range (or a portion of the input range) to 0-100% at the output. That is, scaling allows virtually any part of the selected input range to be scaled to 0% and 100% at the transmitter analog output. The scaling may also be adjusted in the field via front panel push-buttons and status LED's.

Transmitter - Computation: The following gives a brief description of the current available transmitter I/O transfer functions that can be applied to this model via the Configuration Software:

- **None/Proportional (Default):** Each input sample is converted into a directly proportional output update.
- **Linearizer:** Permits the entry of 25 user-defined input-to-output break points to facilitate up to 24-segment linearization of a non-linear sensor signal.

End Points Configuration: Transmitter: Zero/Full-Scale Input maps to Zero/Full-Scale Output.

Alarm Configuration (851T-1500)

Model 851T-1500 units may be configured for simple limit alarms. You may also refer to the IntelliPack 800A Alarm Family for dedicated alarm modules that support other operating functions.

Alarm - Input: The input signal range to the alarm is the full range for the configured input type, regardless of the calib-rated range. If input averaging is used, an averaged input value will be used by the alarm.

Alarm - Mode: Select a High or Low limit for the alarm function of this model. The relay will trip on an increasing input signal for a high limit, and on a decreasing input for a low limit.

Alarm - Setpoint: A high or low setpoint (plus deadband) may be assigned to the relay and is programmable over the entire input range. The relay will enter the alarm state when either the user-defined high or low setpoint is exceeded for the specified amount of time (this allows input transients to be filtered). Relay remains in the alarm state until the input signal has retreated past the defined setpoint, plus any deadband, for the specified amount of time. Please refer to the IntelliPack alarm family for dedicated alarm modules that support other operating functions.

Alarm - Deadband: Deadband is associated with the setpoint and is programmable over the entire input range. Deadband determines the amount the input signal has to return into the "normal" operating range before the relay contacts will transfer out of the "alarm" state. Deadband is normally used to eliminate false trips or alarm "chatter" caused by fluctuations in the input near the alarm point. Note that deadband may also apply to latched alarms. If the alarm is latching, it is recommended that the deadband be set to a minimum.

IMPORTANT: Noise and/or jitter on the input signal has the effect of reducing (narrowing) the instrument's deadband and may produce contact chatter. Another long term effect of contact chatter is a reduction in the life of the mechanical relay contacts. To reduce this undesired effect, increase the deadband setting.

Visual Alarm Indicator: A yellow LED (labeled "RLY") for the relay provides visual status indication of when the relay is in alarm (LED is ON in alarm). This LED is also used in field configuration mode to indicate whether setpoint or deadband is being adjusted.

Relay - Time Delay: Programmable from 0 milliseconds to 4 seconds in 200ms increments for this model (typically used to help filter input transients and avoid nuisance alarming). A minimum delay of 200ms (default) is recommended for increased noise immunity and enhanced conformance to applicable safety standards. This delay does not apply to control of the transmitter's analog output, only the relay.

Relay - Operating Mode: User configurable for "failsafe" operation (relay deenergized in alarm state), or non-failsafe operation (relay energized in alarm state). Failsafe mode provides the same contact closure for alarm states as for power loss, while non-failsafe mode uses alarm contact closure opposite to power loss conditions.

Relay - Reset: The relay may be configured to automatically reset when the input retreats past its setpoint and deadband, or the relay may latch into its alarm state. Use the up or down push-buttons on the front of the module to reset a latched relay and exit the latched state (this may also be accomplished under software control). A latched relay may also be reset remotely via the digital input of this module when this input has been separately configured as a latched alarm reset.

Test Page Tools

This page of the IntelliPack Configuration Program provides tools for communicating with and controlling your module. This page also displays a graphic of the front panel of the module with LED status included. The following functions and controls are supported:

Test – Polling: Click "On" to enable continuous polling of the module. The green status LED should blink while polling is enabled.

Test – Excitation: Because of the limited resolution of the adjustable excitation supply (100 points), the programmed nominal excitation level (Set Value) can only be approximated to within the span of adjustment divided by 99 divisions (93mV, typical). The Actual Value indicates the value obtained through a closed-loop read of the excitation voltage at the bridge via remote sensing. This is also the value used for internal calculations. Note that the Actual Value may not be equivalent to the value measured at the excitation terminals of the module, as the indicated Actual Value has been reduced by the effective line drop since it is taken remotely from the bridge via the SEN± lines. Likewise, a larger than expected lead resistance due to long leads or thin gauge wire may prevent the module from achieving higher excitation levels, and the actual value measured here may differ from the nominal value programmed.

Test – Tare: Tare is the common element of your input measurement that is to be subtracted from subsequent input measurements. It is commonly used to omit the weight of a container. The auto-tare value is determined by clicking the [Tare] button which equates the current input measurement to tare. If Manual (Man) tare is selected, a tare value may be typed directly into the tare field (in microstrain or percent units according to input type). Then click [Tare] to store the value entered. Tare can also be updated by remotely triggering a tare conversion via the TRIG digital input of this module. **Note:** Tare offsets are handled similar to the initial bridge offsets and may include the initial offset if the separate null offset value is reset or set to zero. Tare and initial offset adjustments are kept separate for your convenience to allow you to consider the initial offset and tare weight separately.

Test – [Reset Module]: Clicking on this button will cause a system reset of the module which has the equivalent effect of a power on reset.

Test – Input 1: This area of the Test screen displays the nominal input range, the input value (in percent or microstrain), and the averaged input value (with over-sampling).

Test – Xmtr: This area of the Test screen displays the scaled output value in percent, and the computed value in engineering units (volts, mA).

Test – Output 1: This is a slide control that can be used to temporarily control the output signal irrespective of the input. The current output range and value are also indicated here.

Module Calibration

Note that Calibration of the Divider Ratio should follow calibration of the Reference Voltage. Calibration of Excitation is independent of the Reference Voltage & Divider Ratio.

Excitation Voltage: This calibration is done by measuring the voltage across the sense terminals of the module at the minimum and maximum excitation adjustment limits, then downloading the measured value to the module. The module uses the endpoint information to calculate the incremental voltage step for the adjustable excitation supply (span/99). Simply click on **[1. Min Exc Voltage]** or **[1. Max Exc Voltage]** to set the excitation supply to its minimum or maximum detent. Then measure the voltage across the SEN± terminals with an accurate DVM and enter this value voltage into the Calibration Value field. Next click **[2. Calibrate]** to store the respective endpoint.

IMPORTANT: For best results, the excitation supply should be loaded as required by the final application before calibrating this supply. In addition, allow the module to warm-up a few minutes prior to calibration. Ideally, if normal operation takes place at a temperature much higher or lower than 25°C, the excitation voltage should be calibrated with the module at ambient temperatures close to the final application.

Excitation Voltage – Low: This refers to the minimum excitation output voltage as measured across the SEN± terminals under load.

Excitation Voltage – High: This refers to the maximum excitation voltage as measured across the SEN± terminals under load.

Excitation Voltage – [Restore Factory Calibration]: Click here to cause the module to restore its original factory calibration for the Min/Max excitation limits taken with a 350Ω load at 25°C.

Reference Voltage (Perform Prior To Divider Ratio): This calibration is done by measuring the fixed reference voltage connected to channel 2 of the A/D and downloading this measurement to the module. This reference voltage is nominally 1.225V. The module samples this voltage and uses the resultant count to calculate the A/D reference level and corresponding excitation voltage level, in closed-loop fashion. Recalibration of this value is normally not required, but provided here as a check to correct for component aging or for critical applications that operate at ambient extremes. Simply connect a DVM across the two post vertical header installed on the circuit board and enter the DVM measurement into this field. This requires that the cover be removed temporarily—use strict ESD handling procedures to make this measurement and avoid damage to the module. Click [Calibrate] to store this value.

Reference Voltage – Instructions: Click here for instructions on how to perform this calibration.

Reference Voltage – Calibration Value: Enter the value measured with an accurate DVM connected across the two post header of the circuit board (cover removal required, 1.224V to 1.226V typical).

Reference Voltage – [Calibrate]: Click here to store the Calibration Value in non-volatile memory at the module.

Divider Ratio (Calibrate Reference Voltage First): This calibration is done by measuring the excitation voltage across the SEN± terminals with a DVM, then downloading this measurement to the module. The module uses this information to precisely determine the ratio of the divider that is connected across the excitation supply and used to derive the reference to the A/D. Note that the divider is formed with precision, ±0.1%, ±25ppm/°C resistors between the SEN± terminals.

Divider Ratio – [Instructions]: Click here for instructions on how to perform this calibration.

Divider Ratio – Ratio: This field indicates the current divider ratio stored in the module obtained from the last upload.

Divider Ratio – Calibration Value: This is the excitation voltage measured via an accurate DVM connected across the SEN± terminals. The software compares this value to its measured value and calculates the corresponding ratio of the resistor divider (~9.09K/29.09K).

Divider Ratio – [Calibrate]: Click here store the ratio derived from the Calibration Value in non-volatile memory at the module.

Zero Balance: These controls are repeated here for convenience and also appear on the SG Bridge & Load Cell Calibration Pages. Zero Balance controls are provided to correct for any imbalance in the bridge or load cell circuits for the unstrained or unloaded condition.

Zero Balance - [Null]: With no load applied to any element of the bridge or to the loads cell, click this button to cause the "unstrained" or "unloaded" offset to be determined and to effectively zero the indicated strain.
IMPORTANT: . Do not combine tare weight with initial offset.

Zero Balance - [Reset Null]: This value restores the existing bridge offset value to zero.
IMPORTANT: Be sure to invoke [Reset Null] prior to changing input types between SG Bridge and Load Cells, as this offset is stored in microstrain units for bridge inputs, and percent for load cell inputs. Failure to reset the null value to zero will generate unexpected measurement error if the input type is later changed.

Zero Balance – uStrains or % Field: This field indicates the current "null value" or bridge/load cell offset. This value is automatically removed from the indicated measurement and tracked separate from tare. Note that large offsets may be indicative of strain gauge or load cell problems.

Strain Gauge (Bridge) Calibration Parameters
The information of this page is not applicable to Load Cell Input Types.

Bridge Calibration – Zero Balance: These controls are provided to correct for any imbalance in the bridge circuit for the unstrained or unloaded condition. Be sure to perform Zero balance prior to shunt calibration. The initial bridge offset is the output voltage of the bridge with no applied stress. Due to slight differences in the bridge elements and variations in application, real bridge circuits are rarely balanced in the unstrained condition and this offset must be accounted for via zero balance.
[Reset Null]: This value restores the existing bridge offset null value to zero.
IMPORTANT: Be sure to invoke [Reset Null] prior to changing input types between SG Bridge and Load Cells, as this offset is stored in microstrain units for bridge inputs, and percent for load cell inputs. Failure to reset the null value to zero will generate unexpected measurement error if the input type is later changed.
[Null]: With no load applied to any element of the bridge, click this button to cause the "unstrained" bridge offset to be determined and to effectively zero the indicated strain.
IMPORTANT: Do not combine tare weight with initial offset.
uStrains: The microstrains field indicates the current "null value" or bridge offset. This value is automatically removed from the measured strain and tracked separate from tare. Note that large offsets may be indicative of strain gauge problems.

Bridge Calibration – Calibration Element: This specifies the bridge element R1, R2, R3, or R4 that is to be shunted to accomplish shunt calibration or instrument scaling. Selection of R1, R2, R3, or R4 will require a shunt resistance to be applied across that element of the bridge.

Bridge Calibration – Software Gain Factor: This software gain is applied to the measured strain to rescale the indicated measurement to match the internally calculated simulated strain during shunt calibration. The Software Gain Factor is set to 1.0 by default, but may vary following shunt calibration. A similar effect to varying the Software Gain Factor can be achieved by varying the reciprocal term, Instrument Gauge Factor instead, as required to re-scale measured strain. Utilizing the Software Gain Factor to re-scale your measurements will allow you to keep the Instrument Gauge Factor equivalent to the strain Gauge Factor if so desired.

Bridge Calibration – Instrument Gauge Factor: The instrument gauge factor is normally set equivalent to the strain Gauge Factor per the manufacturer's specification. The Instrument Gauge Factor is used to generate the indicated (measured) value. This value may be varied slightly to rescale and modify the indicated strain measurement to match the simulated strain while performing shunt calibration.

Bridge Calibration - Shunt Resistance: This is the value of the shunt resistor in ohms applied across the bridge calibration element specified. Enter your shunt resistance and click on [Update] to cause the software to calculate a Simulated Strain, and to simultaneously measure the strain.

Bridge Calibration – [Update]: Click this button to force the software to calculate a simulated strain using the Gauge Factor and the value of Shunt Resistance you have entered, and to also take a measurement using the Instrument Gauge Factor and Software Gain Factor you have specified. You would then vary your Instrument Gauge Factor and/or Software Gain Factor slightly, until the Measured Strain converges with the Simulated Strain. This effectively re-scales the module's strain indicator via shunt calibration.

Bridge Calibration – [Shunt Resistor Calc]: Click this button to have the software calculate the shunt resistor value required to produce the value of Simulated Strain that you have entered in the Simulated Strain Field.

Bridge Calibration – Simulated Strain: This value is calculated based on the value of shunt resistance you have specified and the Gauge Factor (from the Strain Gauge Setup screen). It is updated each time you click [Update]. Alternately, you can enter a value of simulated strain, and click on [Shunt Resistor Calc] to estimate the resistor required to produce the value of simulated strain you entered.

Bridge Calibration – Measured Strain: This value is measured each time you click [Update] and is calculated from the input signal using the Instrument Gauge Factor & Software Gain Factor you have specified. You vary the Instrument Gauge Factor and/or Software Gain Factor to make this value converge with the Simulated Strain value during Shunt Calibration.

Load Cell Calibration Parameters

The information of this page is not applicable to strain gauge bridge Input Types.

Load Calibration – Zero Balance: These controls are provided to correct for any initial load cell offset in the unloaded state.

[Null]: With no load applied to the load cell, click this button to cause the "unloaded bridge offset to be determined and to effectively zero the indicated load.

IMPORTANT: It is recommended that you not combine tare weight with initial offset, as this module provides controls to adjust each separately.

[Reset Null]: This value restores the existing load cell offset value to zero. This should be done prior to changing input types as the offset is stored in percent for load cell inputs, and microstrain units for bridge inputs.

IMPORTANT: Be sure to invoke [Reset Null] prior to changing input types between Load Cell and SG Bridges, as this offset is stored in percent for load cells, and microstrain units for bridge inputs. Failure to reset the null value to zero will generate unexpected measurement error if the input type is later changed.

Percent(%): The percent field indicates the current "null value" or load cell offset in percent. This value is automatically removed from the measured load and tracked separate from tare. Note that large offsets may be indicative of a problem with the load cell.

Load Calibration – Calibration Load: This is the known load applied to the load cell in percent of span units. Your calibration load should be greater than or equal to 60% of full-scale.

Load Calibration – Measurement Gain: This software gain is applied to the measured load to rescale the indicated measurement to match the calibration load during load calibration. The Software Gain Factor is set to 1.0 by default, but may vary following load calibration. You may click [Calc Ideal Gain] to have the software insert the gain required into this field to equate Input and Calibration Load.

Load Calibration – Input: This is the current measured load with Measurement Gain applied. It is updated each time the [Update] button is clicked. The idea is to rescale the *Input* measurement until it converges with *the Calibration Load* value.

Load Calibration – [Calc Ideal Gain]: Click this button to have the software calculate the ideal Measurement Gain required to equate the current Input measurement with the Calibration Load. Next, click "Update" to download the Measurement Gain to the module and take a new Input measurement.

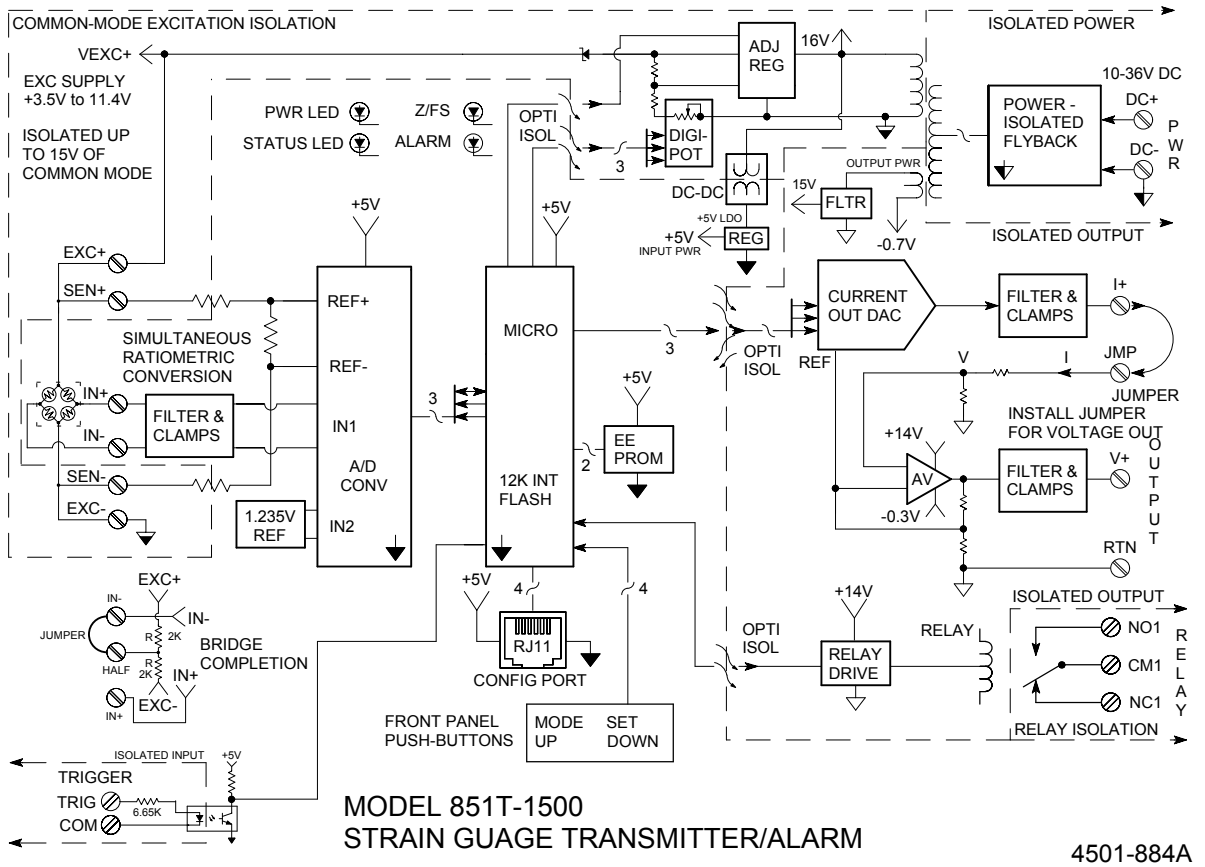
Load Calibration – [Update]: Click this button to download Measurement Gain to the module and take an input measurement with the Measurement Gain applied. You would then compare the resultant Input value to the Calibration Load value and vary the Gain Factor as required until the Input is equivalent to the Calibration Load. Measurement Gain effectively rescales the module's indicator by applying gain to the internal result.

Analog Output Configuration

Output Calibration: The configuration software can be used to calibrate the output conditioning circuit of this module (DAC). A slide control is provided on the Output Calibration page to set the output to its respective low or high endpoint. A DVM is then used to measure the corresponding output current or voltage, and this measurement is entered into the low or high calibration value field. Click on [Calibrate] to set the low or high endpoint. For best results, calibrate the Low value before the High value.

You may also click on [Restore Factory Calibration] to return the output calibration to its initial factory calibration.

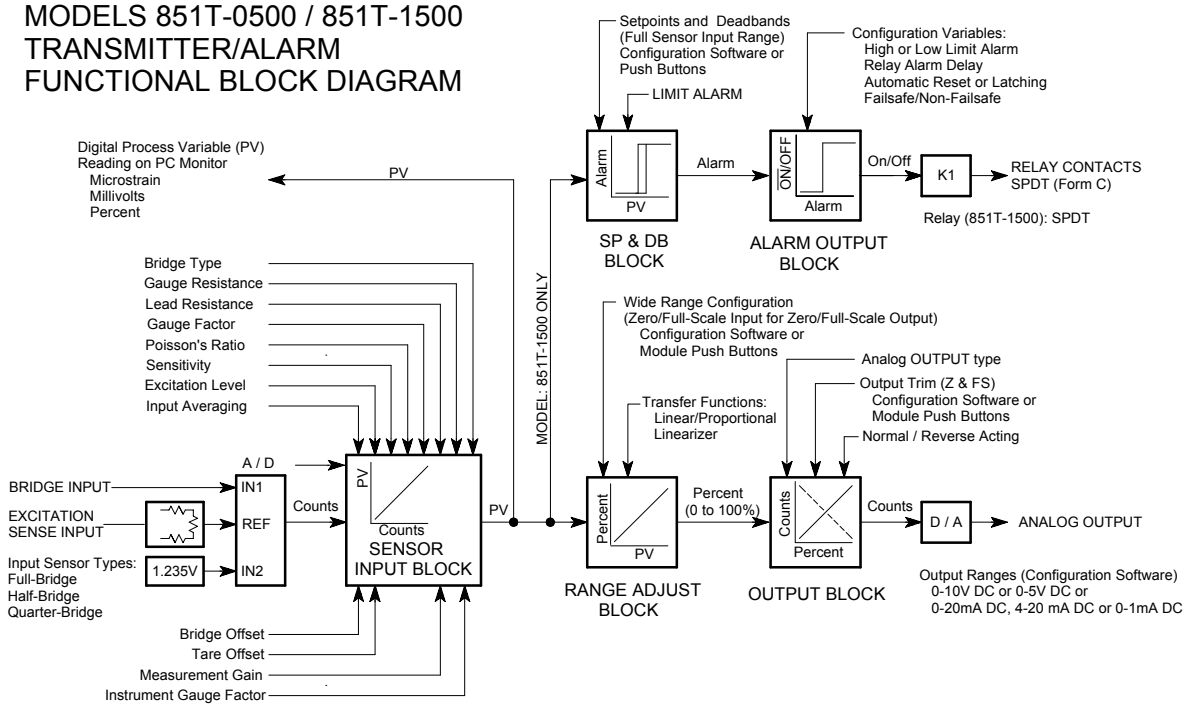
Notes:



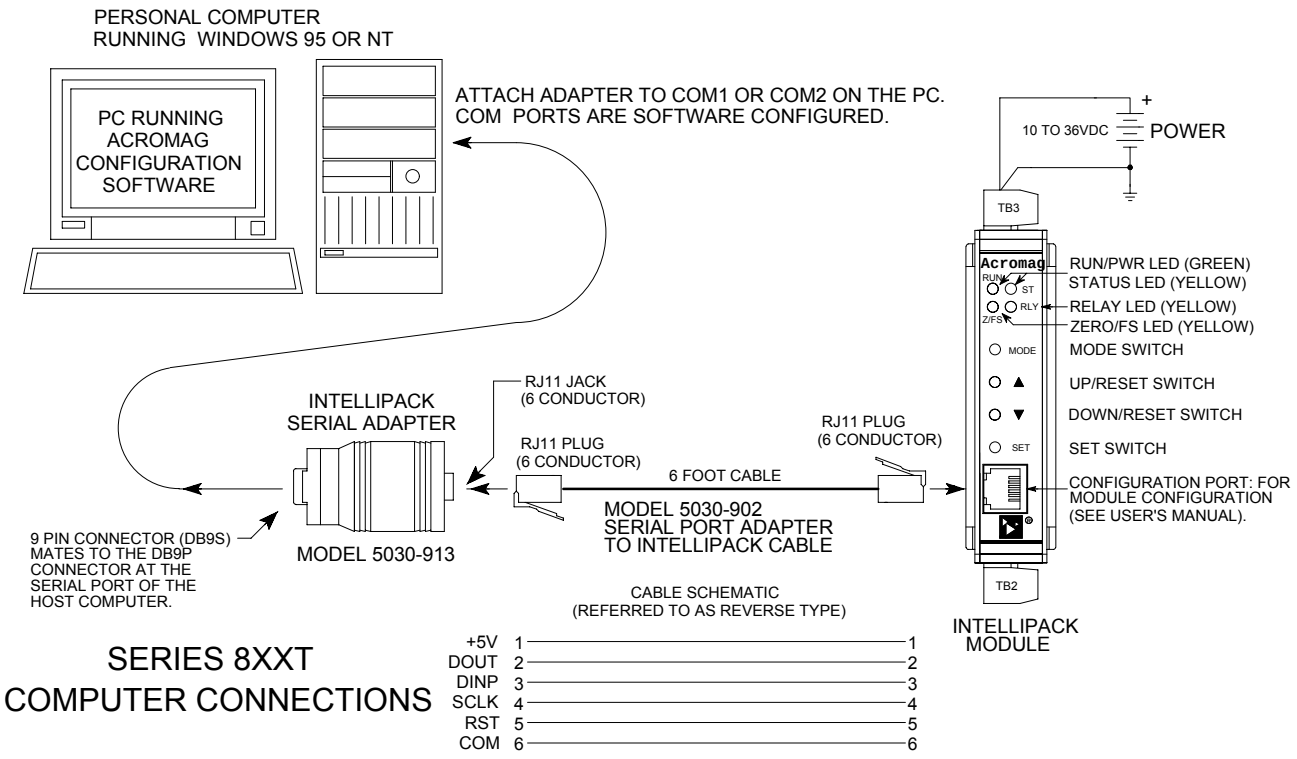
MODEL 851T-1500
STRAIN GUAGE TRANSMITTER/ALARM

4501-884A

MODELS 851T-0500 / 851T-1500 TRANSMITTER/ALARM FUNCTIONAL BLOCK DIAGRAM



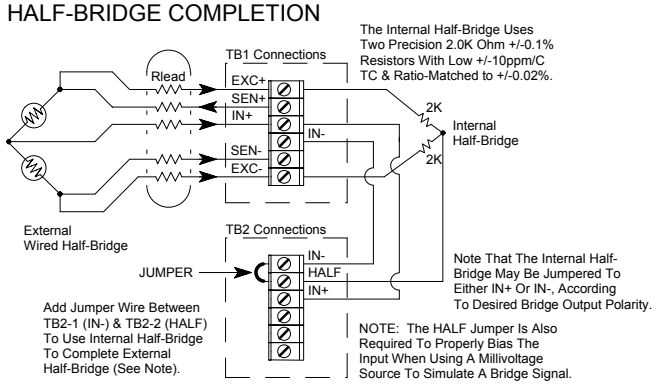
4501-885A



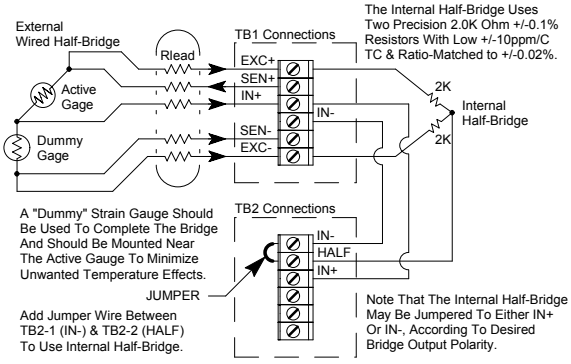
SERIES 8XXT COMPUTER CONNECTIONS

4501-643A

HALF-BRIDGE COMPLETION


TB1 Connections
Rlead
EXC+
SEN+
IN+
IN-
SEN-
EXC-
2K
2K
Internal Half-Bridge
The Internal Half-Bridge Uses Two Precision 2.0K Ohm +/-0.1% Resistors With Low +/-10ppm/C TC & Ratio-Matched to +/-0.02%.
External Wired Half-Bridge
TB2 Connections
JUMPER
IN-
HALF
IN+
Add Jumper Wire Between TB2-1 (IN-) & TB2-2 (HALF) To Use Internal Half-Bridge To Complete External Half-Bridge (See Note).
Note That The Internal Half-Bridge May Be Jumpered To Either IN+ Or IN-, According To Desired Bridge Output Polarity.
NOTE: The HALF Jumper Is Also Required To Properly Bias The Input When Using A Millivoltage Source To Simulate A Bridge Signal.

QUARTER-BRIDGE COMPLETION


External Wired Half-Bridge
Rlead
TB1 Connections
EXC+
SEN+
IN+
IN-
SEN-
EXC-
Active Gage
Dummy Gage
2K
2K
Internal Half-Bridge
The Internal Half-Bridge Uses Two Precision 2.0K Ohm +/-0.1% Resistors With Low +/-10ppm/C TC & Ratio-Matched to +/-0.02%.
A "Dummy" Strain Gauge Should Be Used To Complete The Bridge And Should Be Mounted Near The Active Gauge To Minimize Unwanted Temperature Effects.
TB2 Connections
JUMPER
IN-
HALF
IN+
Add Jumper Wire Between TB2-1 (IN-) & TB2-2 (HALF) To Use Internal Half-Bridge.
Note That The Internal Half-Bridge May Be Jumpered To Either IN+ Or IN-, According To Desired Bridge Output Polarity.

851T-0500 / 851T-1500 BRIDGE COMPLETION CONNECTIONS

Sense Leads Sample The Excitation Level At The Bridge And Form The Ratiometric A/D Converter Reference Voltage.

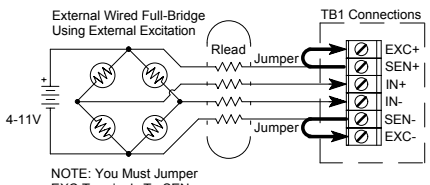
Small Sense Lead Currents (Less Than 0.5mA) Make Sense Lead Resistance Insignificant.

High-Impedance Differential Input Makes Input Lead Resistance Insignificant.

Excitation Lead Currents (Up To 120mA) Must Consider Lead Resistance And Corresponding Drop In Excitation Voltage At The Bridge.

A Second Input Of The A/D Monitors The The Excitation Voltage Level And The Corresponding A/D Reference.

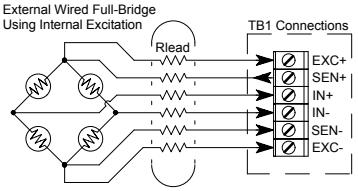
FULL-BRIDGE CONFIGURATION WITH EXTERNAL EXCITATION



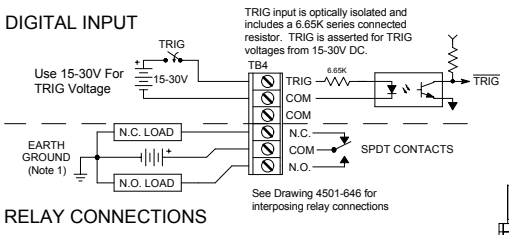
NOTE: You Must Jumper EXC Terminals To SEN Terminals As Shown.

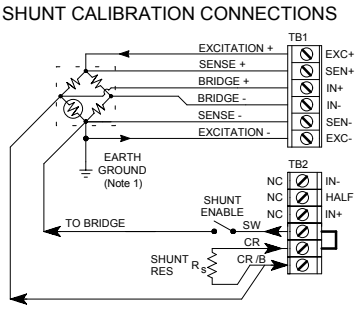
CAUTION: The Internal Excitation Supply Must Be Turned OFF Prior To Connecting To An External Excitation Supply.

FULL-BRIDGE CONFIGURATION USING INTERNAL EXCITATION



4501-887A



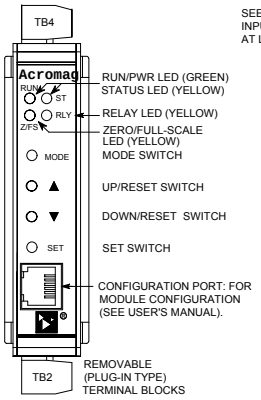


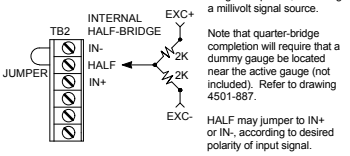
NOTE 1: This ground connection is recommended for best results. However, if sensors are inherently connected to ground, use caution and avoid making additional ground connections which could generate ground loops and measurement error.

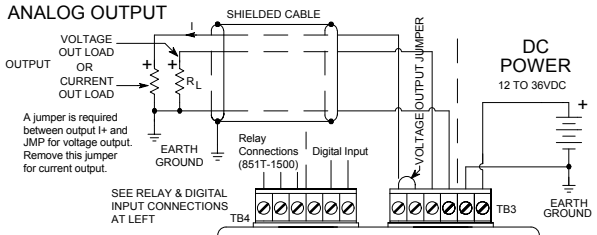
NOTE 2: Be sure to complete input connections prior to applying power or resetting the module.

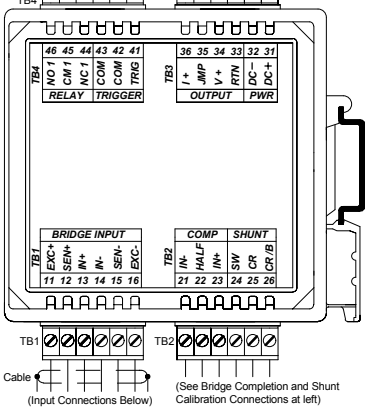
WARNING:
For compliance to applicable safety and performance standards, the use of shielded cable is recommended as shown. Additionally, the application of earth ground must be in place as shown in this drawing. Failure to adhere to sound wiring and grounding practices may compromise safety and performance.

Safety guidelines may require that this device be housed in an approved metal enclosure or sub-system, particularly for applications with voltages greater than or equal to 75V DC or 50V AC.



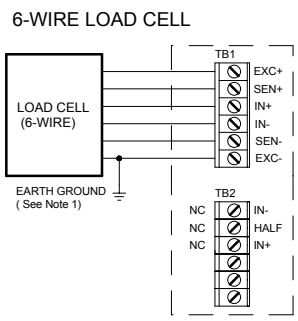

BRIDGE COMPLETION
Add jumper for half or quarter bridge completion, or if using a millivolt signal source.
TB2
INTERNAL HALF-BRIDGE
EXC+
IN-
HALF
IN+
JUMPER
2K
2K
EXC-
Note that quarter-bridge completion will require that a dummy gauge be located near the active gauge (not included). Refer to drawing 4501-887.
HALF may jumper to IN+ or IN-, according to desired polarity of input signal.

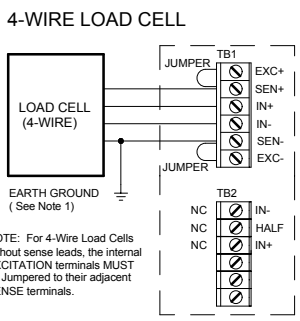


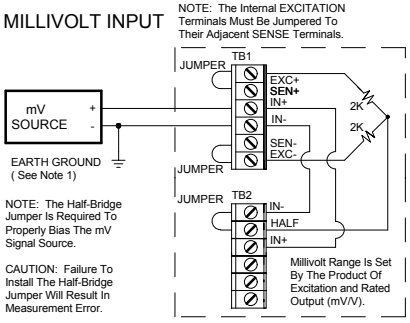


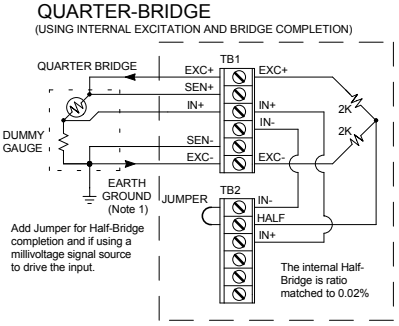
ELECTRICAL CONNECTIONS
MODELS 851T-0500 AND 851T-1500

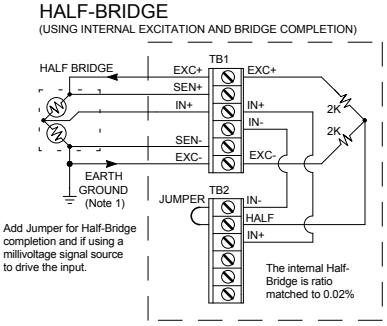
4501-886A
PG 1 OF 2

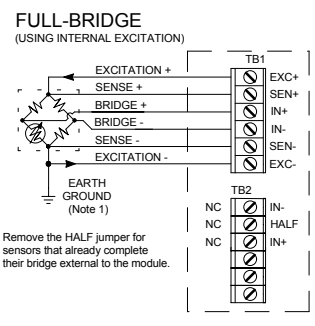












NOTE 1: This ground connection is recommended for best results. However, if sensors are inherently connected to ground, use caution and avoid making additional ground connections which could generate ground loops and measurement error.

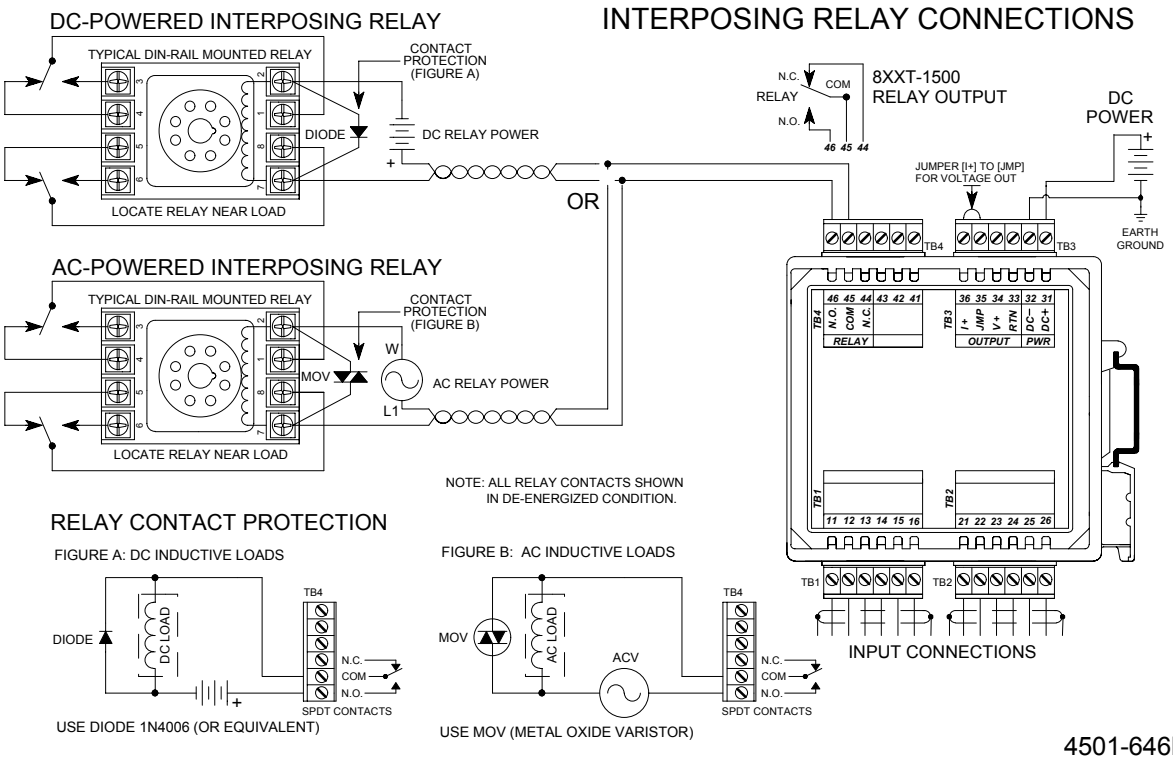
NOTE 2: Be sure to complete input connections prior to applying power or resetting the module.

IMPORTANT - EXTERNAL EXCITATION

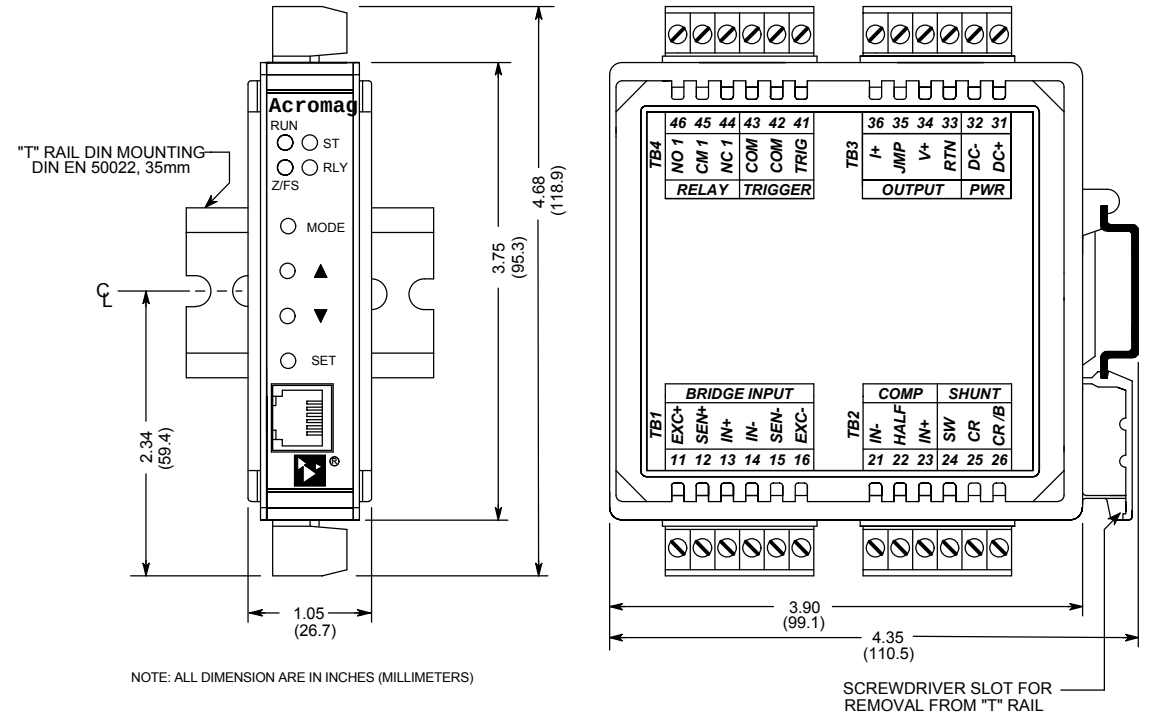
Module Excitation Terminals MUST be jumpered to their adjacent sense terminals for sensors utilizing external excitation.

WARNING: You MUST turn OFF the internal excitation supply prior to connecting an external excitation supply or damage to the unit may occur.

4501-886A
PG 2 OF 2



4501-646B


Acromag
RUN
ST
RLY
Z/FS
MODE
SET
"T" RAIL DIN MOUNTING DIN EN 50022, 35mm
4.68 (118.9)
3.75 (95.3)
2.34 (59.4)
1.05 (26.7)
NOTE: ALL DIMENSION ARE IN INCHES (MILLIMETERS)
TB4 46 45 44 43 42 41 NO 1 CM 1 NC 1 COM COM TRIG RELAY TRIGGER
TB3 36 35 34 33 32 31 I+ JMP V+ RTN DC- DC+ OUTPUT PWR
TB1 11 12 13 14 15 16 EXC+ SEN+ IN+ IN- SEN- EXC- BRIDGE INPUT
TB2 21 22 23 24 25 26 IN- HALF IN+ SW CR CR/B COMP SHUNT
3.90 (99.1)
4.35 (110.5)
SCREWDRIVER SLOT FOR REMOVAL FROM "T" RAIL

INTELLIPACK TRANSMITTER ENCLOSURE DIMENSIONS

4501-888A